Plant Anatomy

= the study of plant cell and tissue structure

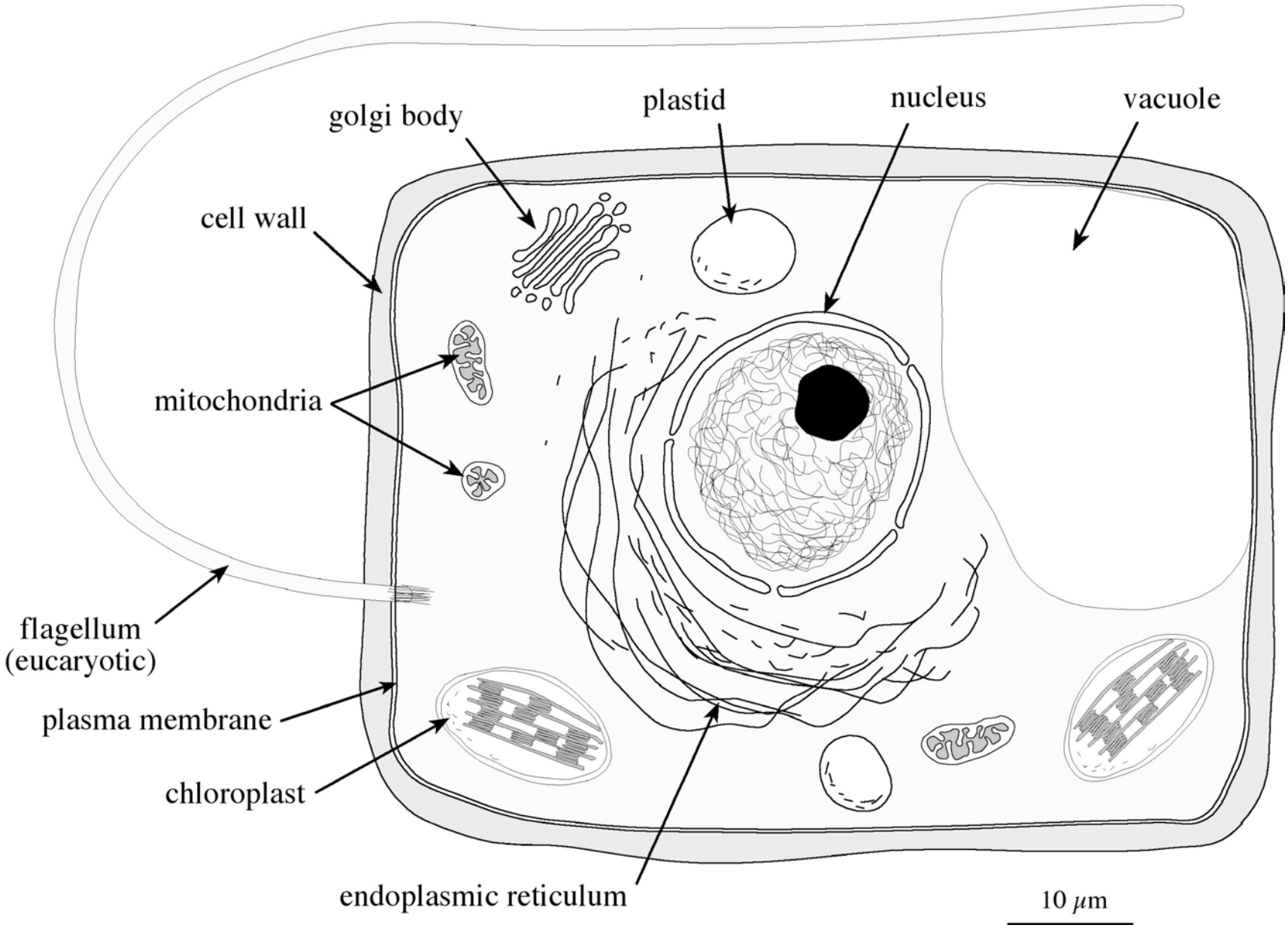
Plant cell structure

"Cell" - originally coined by Robert Hooke, in 1600's.

Cell theory:

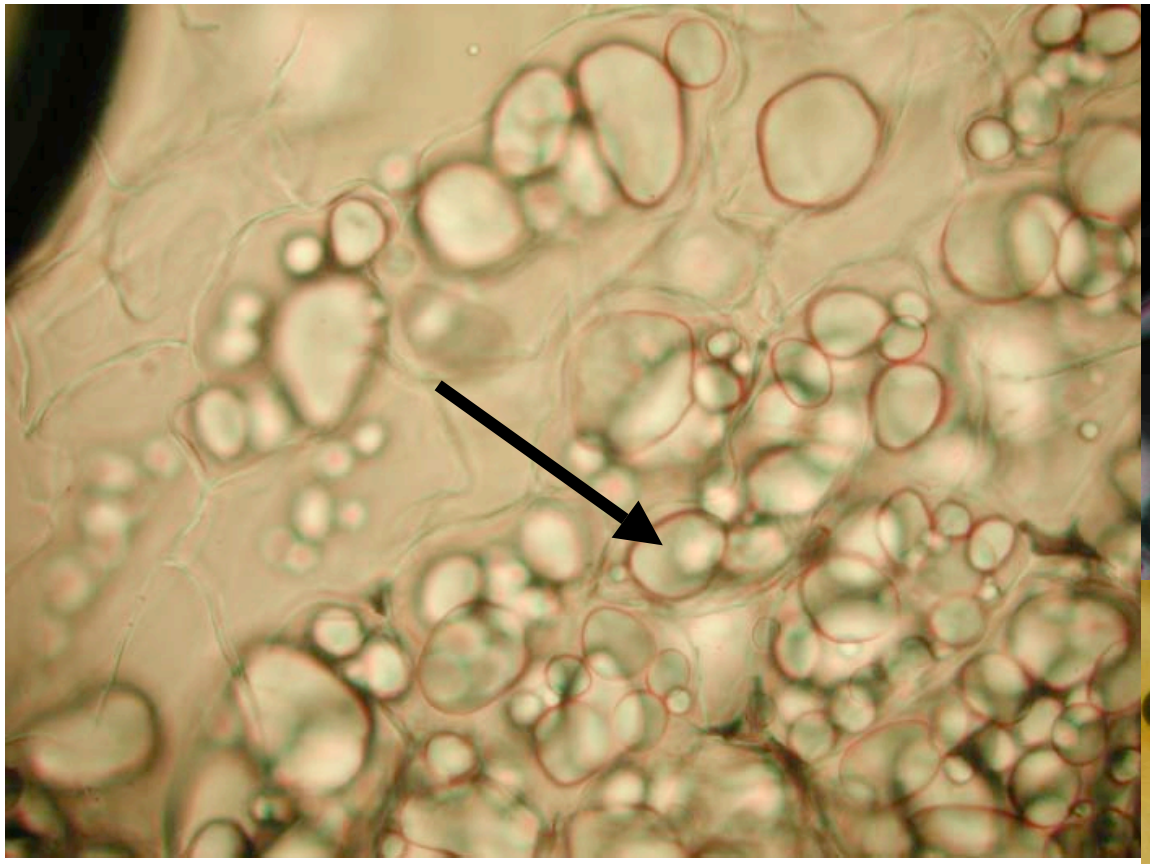
1) All life made of cells
2) Cells arise from pre-existing cells
3) Cells units of metabolism
4) Cells contain complete DNA, hereditary substance.

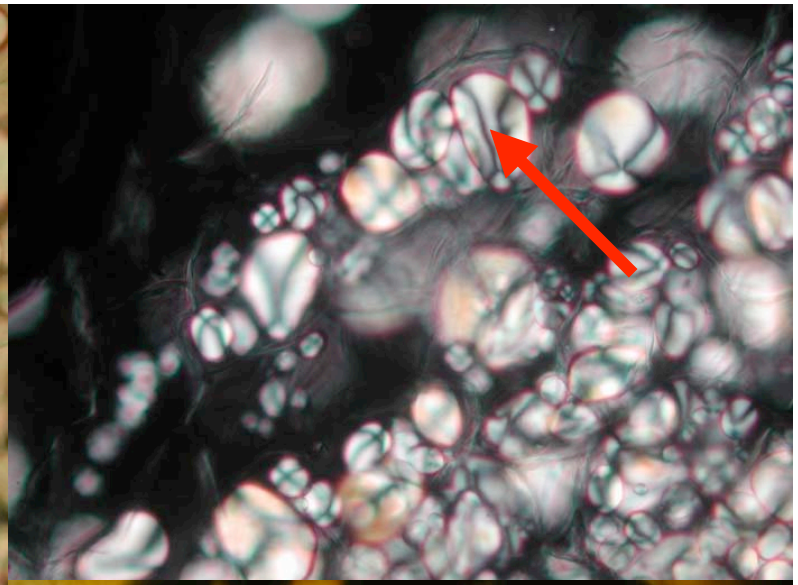
Cell structure



Ergastic substances

= by-products of metabolism

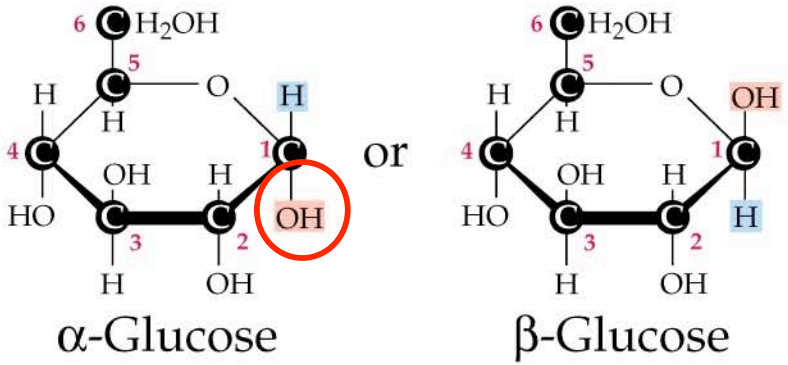




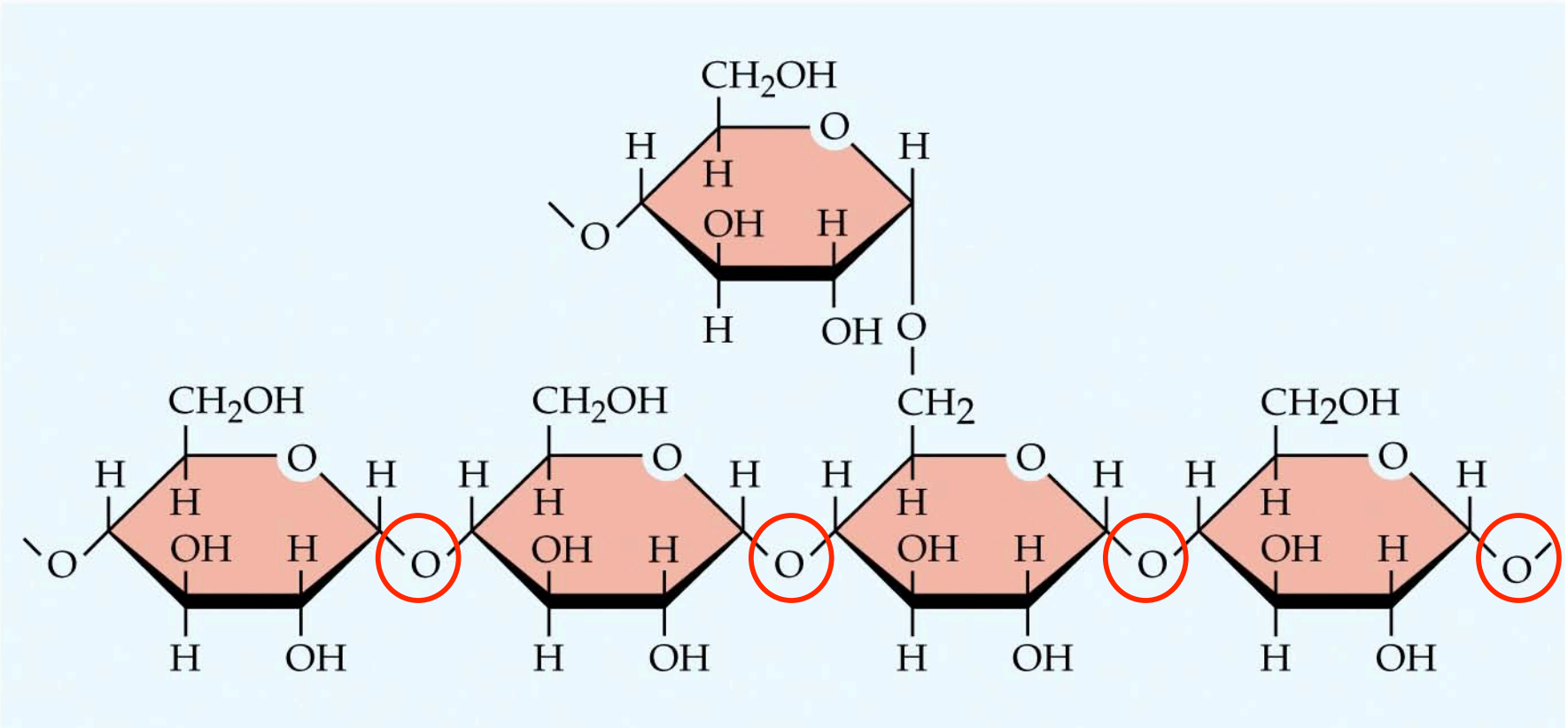
amyloplasts - starch grains

= polymer of alpha-glucose

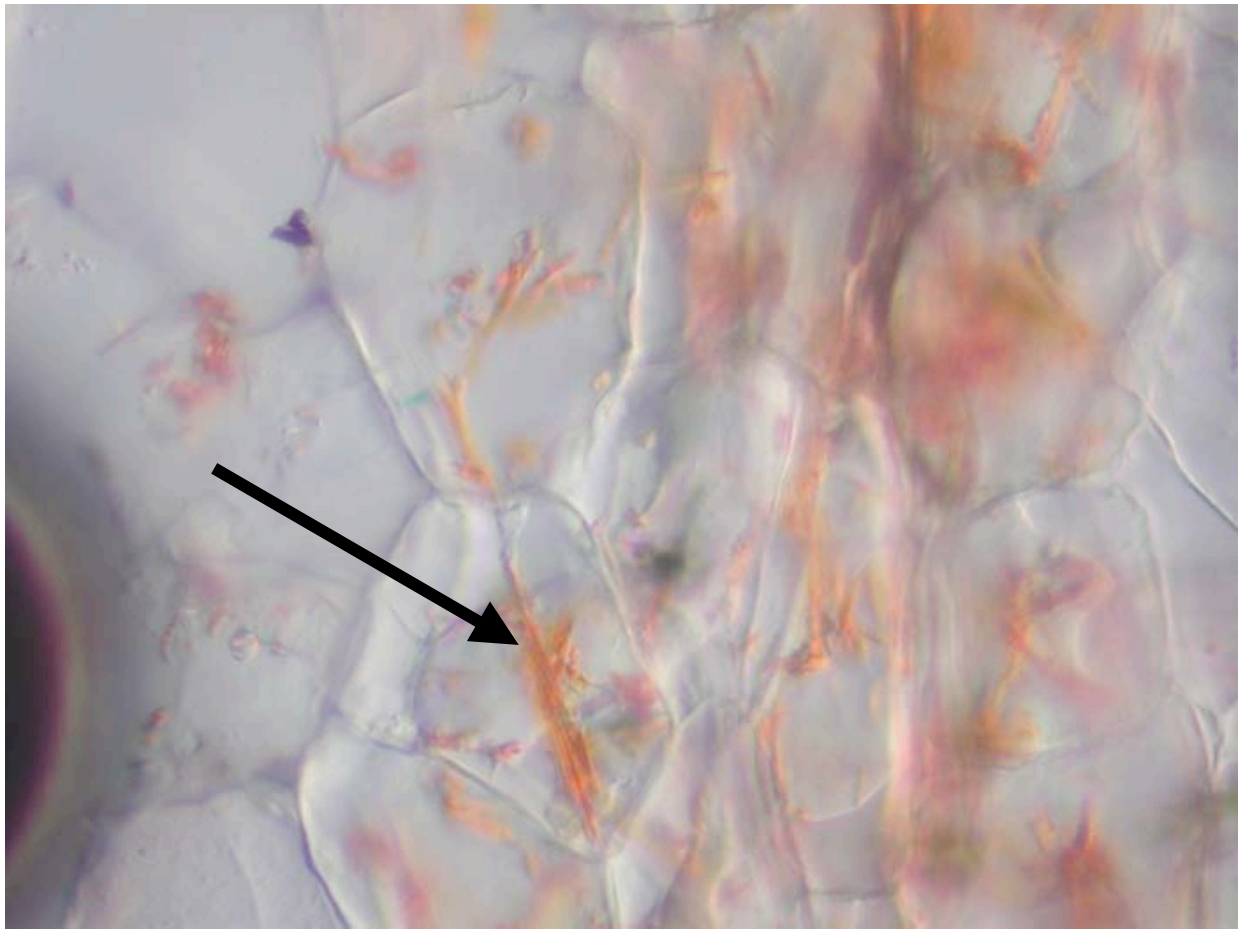
2 forms of glucose



Starch and glycogen



Ergastic substances



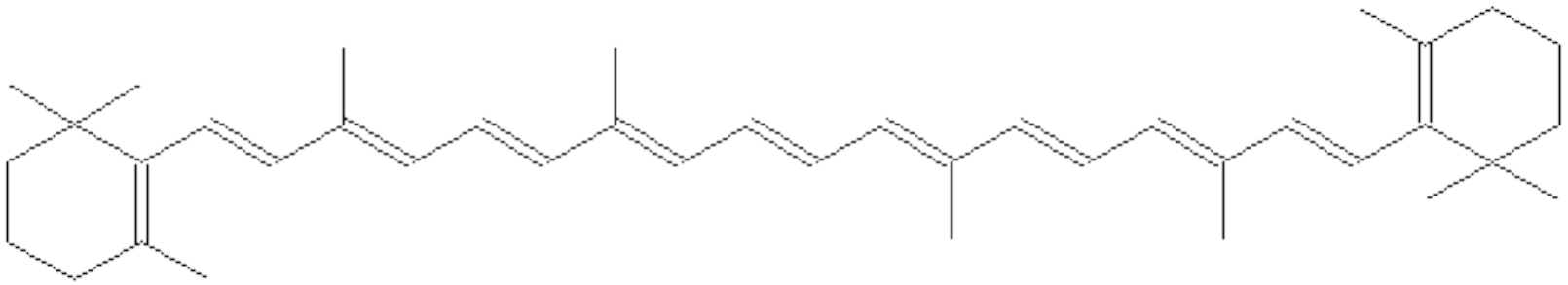
chromoplasts - pigmented bodies, composed of carotenoids (e.g., carotene); cause red/orange coloration.

carotene

when hydrolysed, yields two vitamin A molecules:

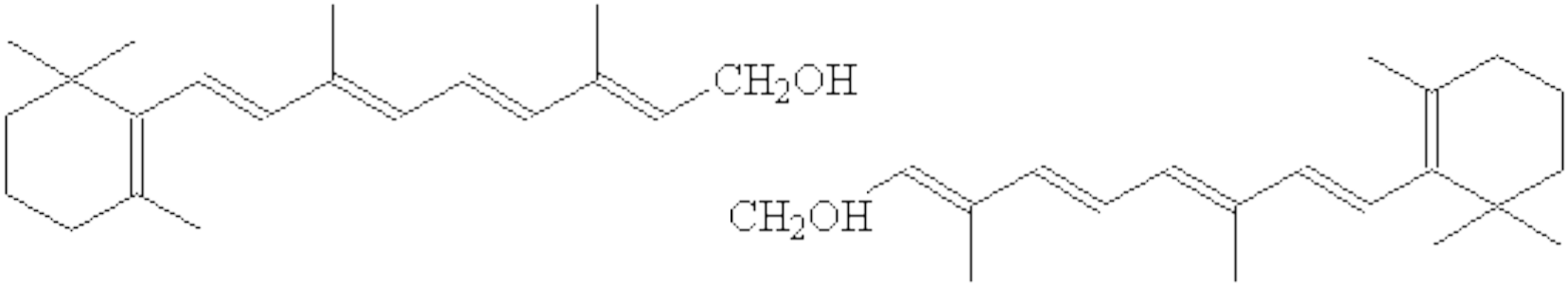
carotene ---> vitamin A + vitamin A

function in plants is pigmentation, however



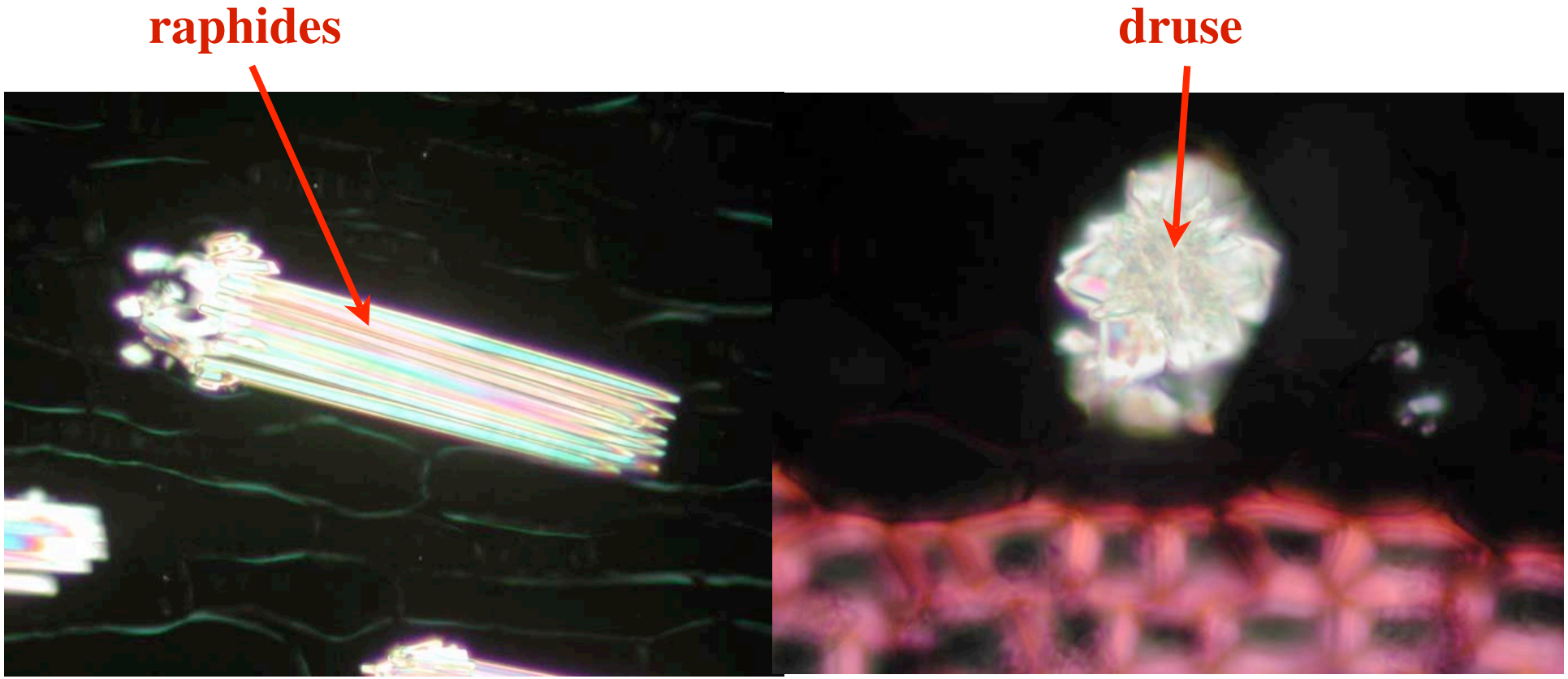
carotene

+ 2 H_2O



2 vitamin A

Ergastic substances



crystals - calcium oxalate (e.g., raphides/druses) or silica

- waste/metabolic products or protective (deter herbivory)

Ergastic substances

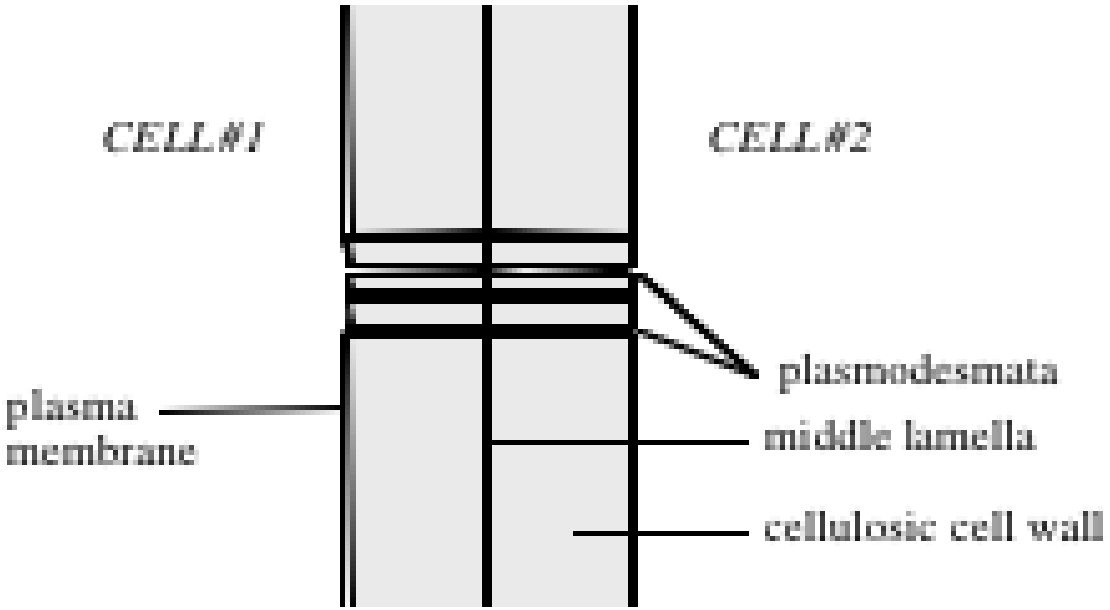
aleurone grains - protein (storage)

tannins - phenol derivatives (deter herbivory, deter infection)

fats, oils, waxes - tri-/di-glyerides (storage, secretion)

Cell structure

- Cell wall
  - Primary (1˚) cell wall
    - Formed during growth/expansion of cells
    - Made up mainly of **cellulose**
      = polymer of beta-glucose units
  - Plasmodesmata
    - Holes in 1˚ cell wall, allow for cell to cell communication

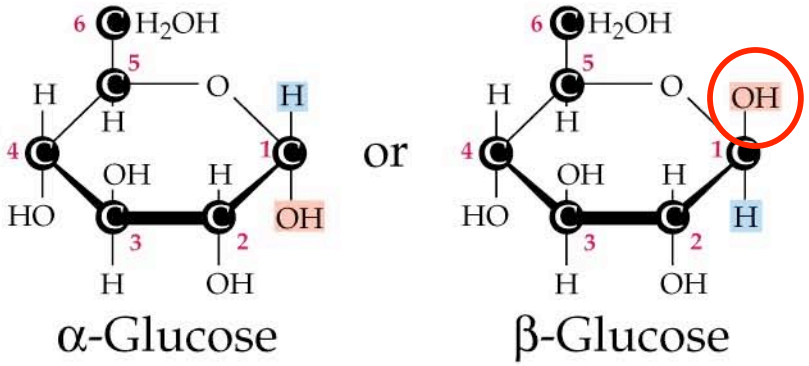


cell wall:

cellulosic

plasmodesmata

cellulose: beta form of glucose



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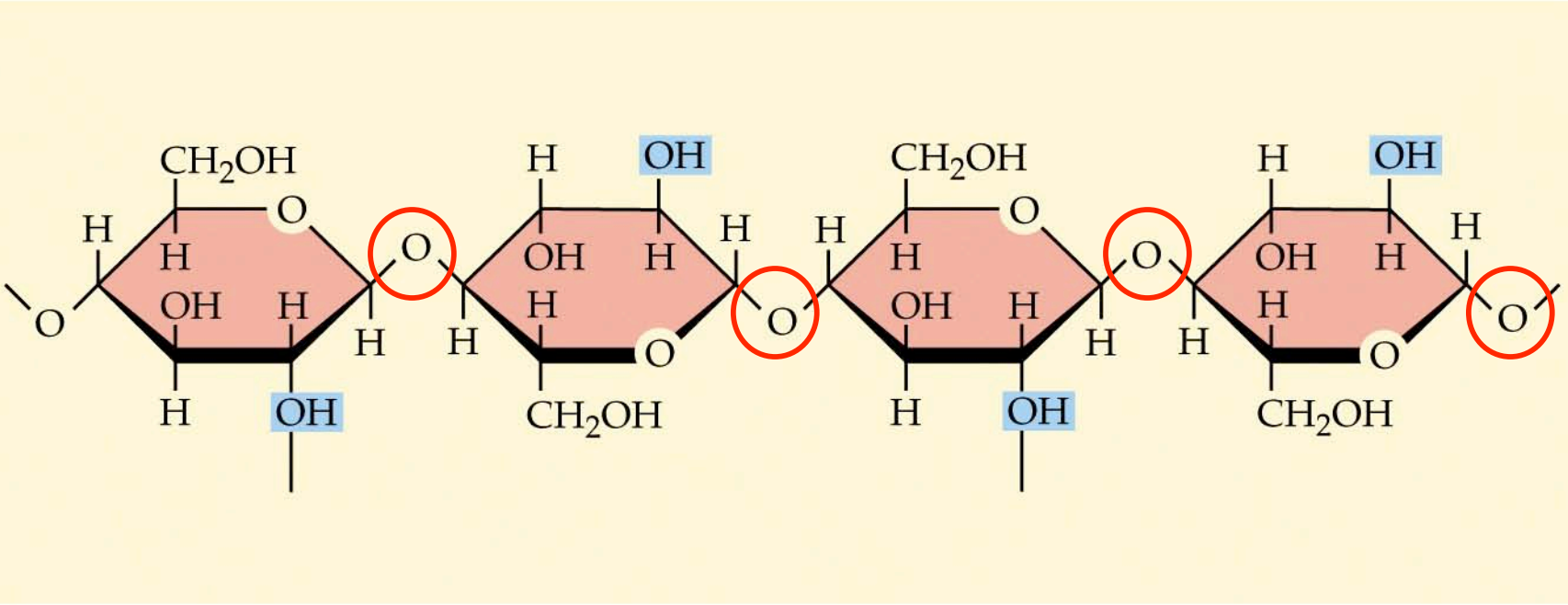
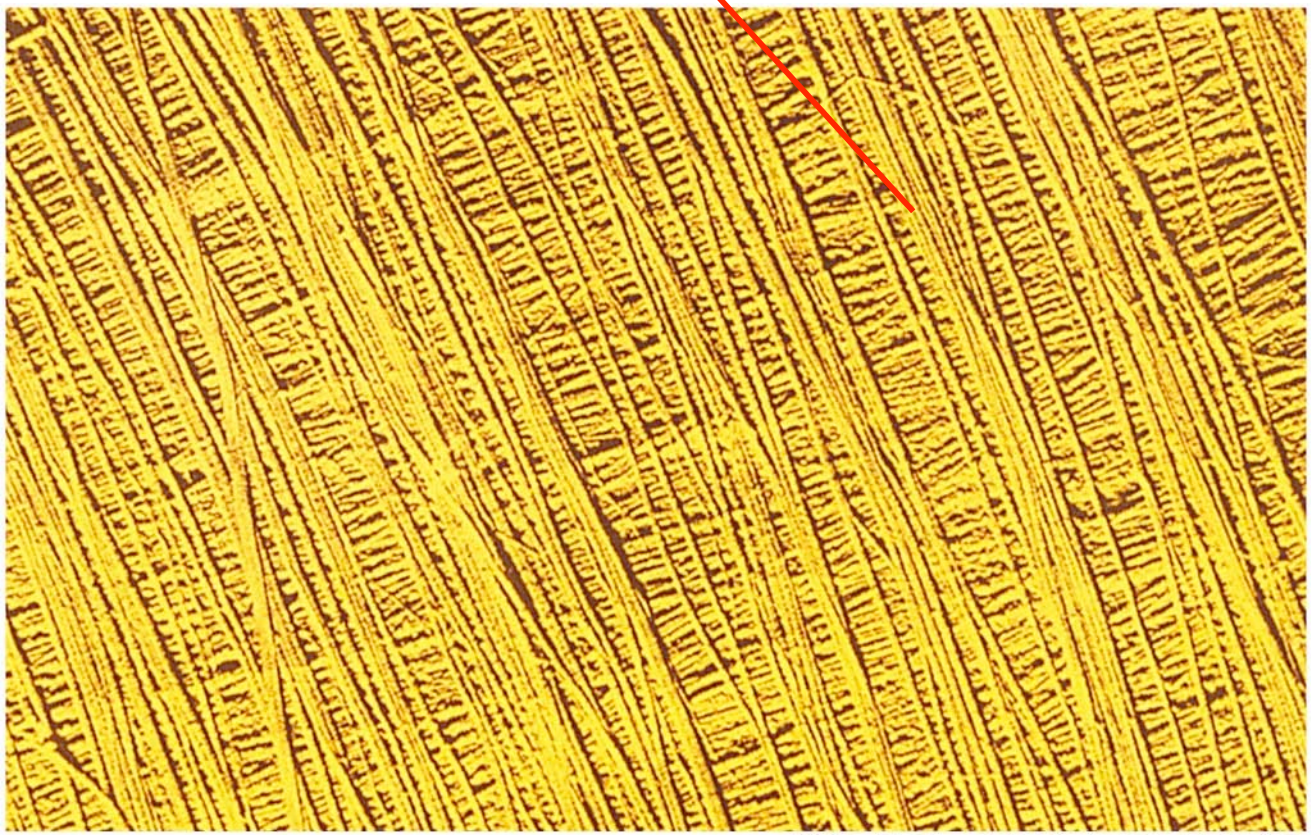
Cellulose



Cellulosic cell wall

made of cellulose **microfibrils**



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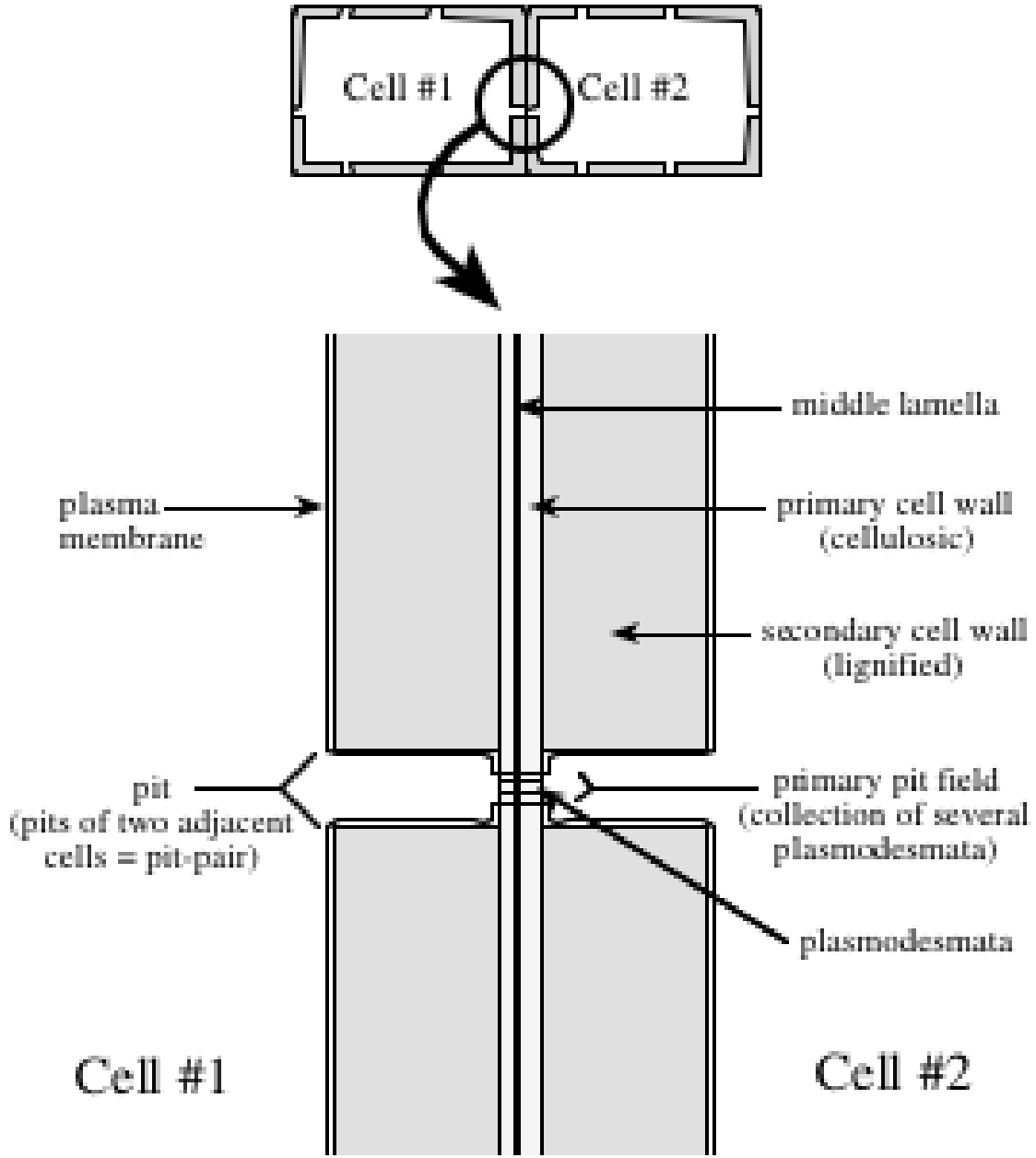
Cell structure

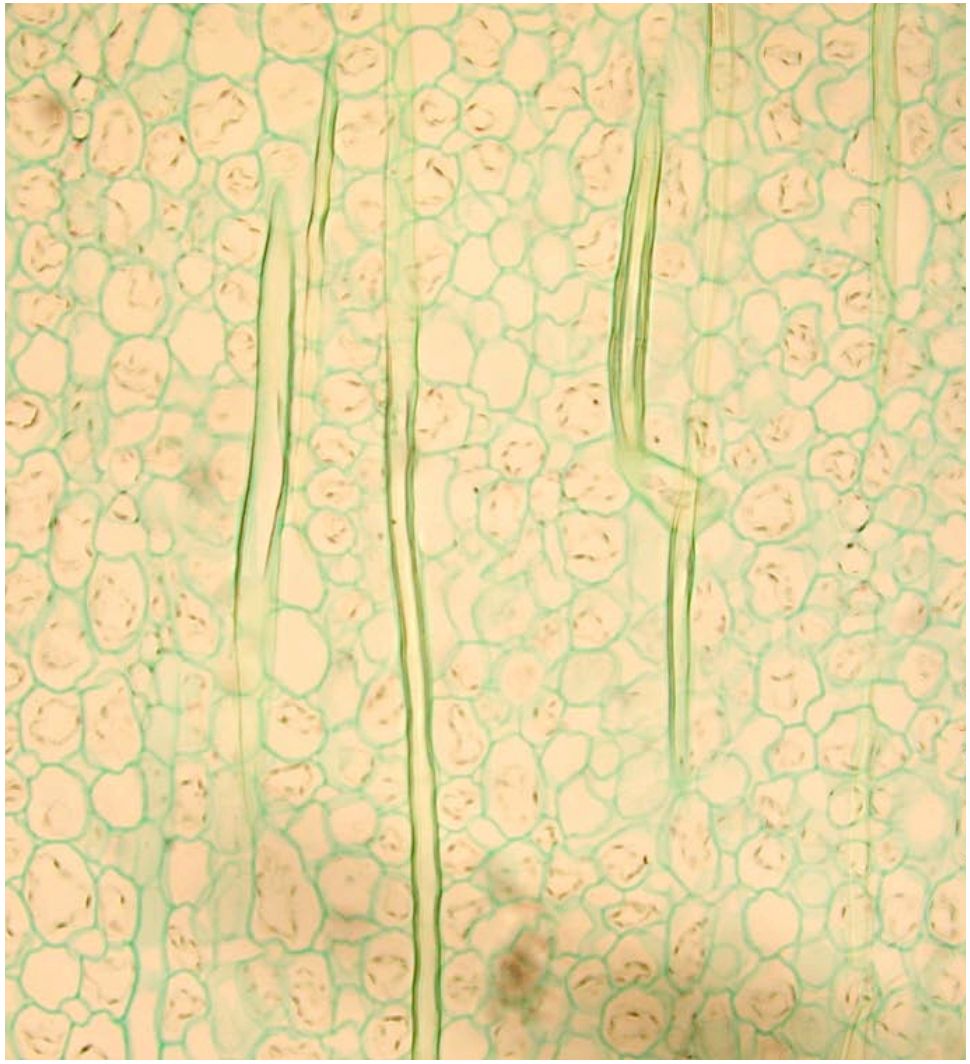
Cell wall

- Secondary (2˚) cell wall
  - Formed after growth/expansion of cells, inside original primary cell wall
  - Made up mainly of **lignin**
    - = polymer of phenolic units
    - hard subtance
- Pits - holes in secondary cell wall

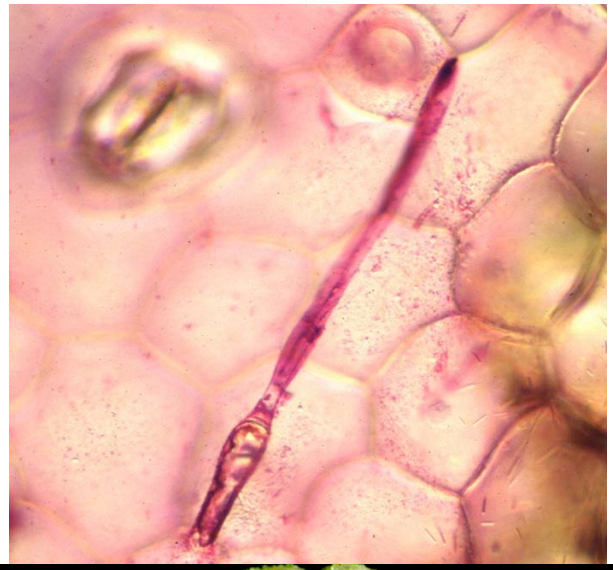
lignin - secondary cell wall



Secretory cells



laticifers - cells that secrete **latex**, containing isoprenes (e.g., rubber)



glandular trichomes, oil ducts - secrete oils

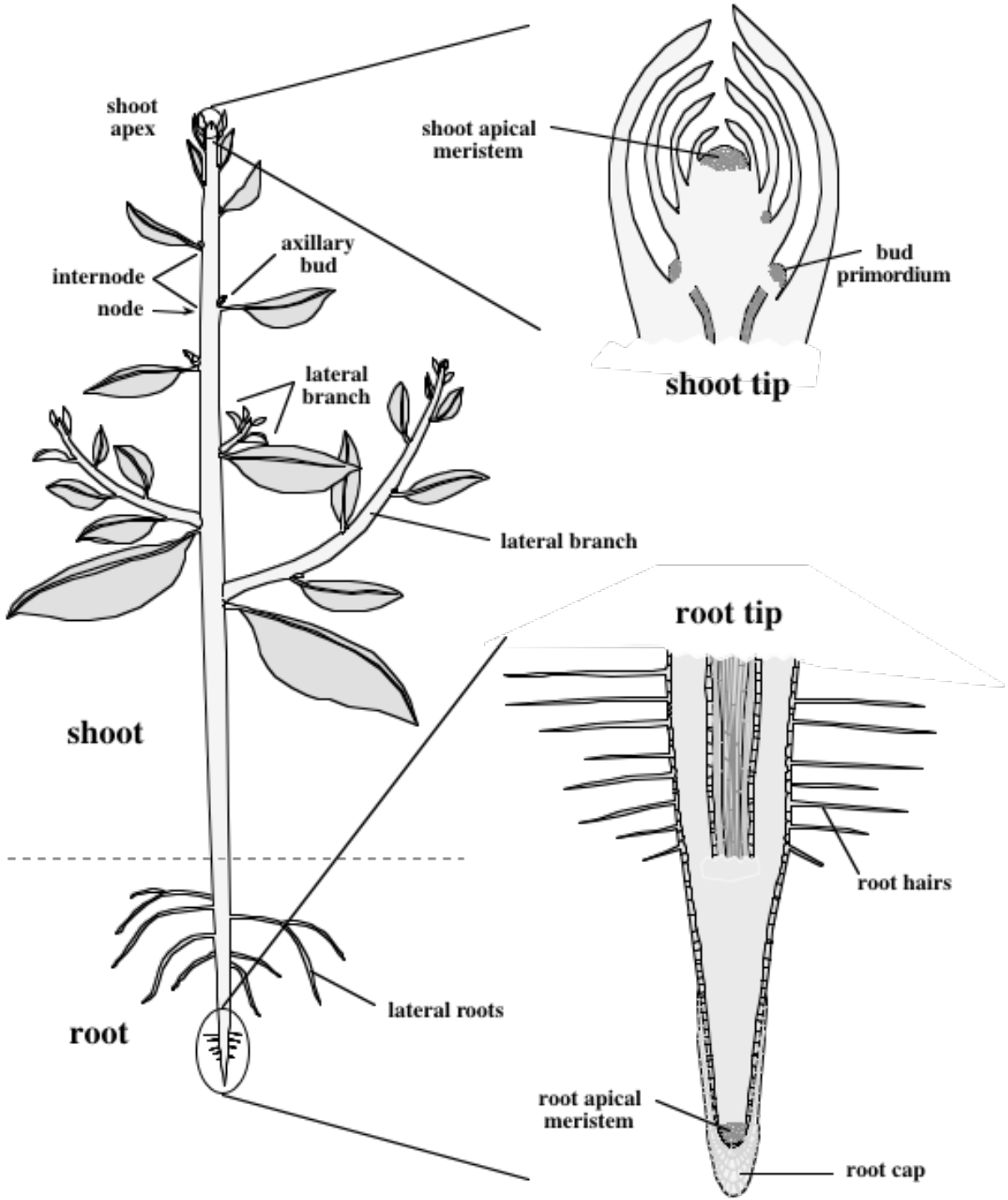
Plant growth

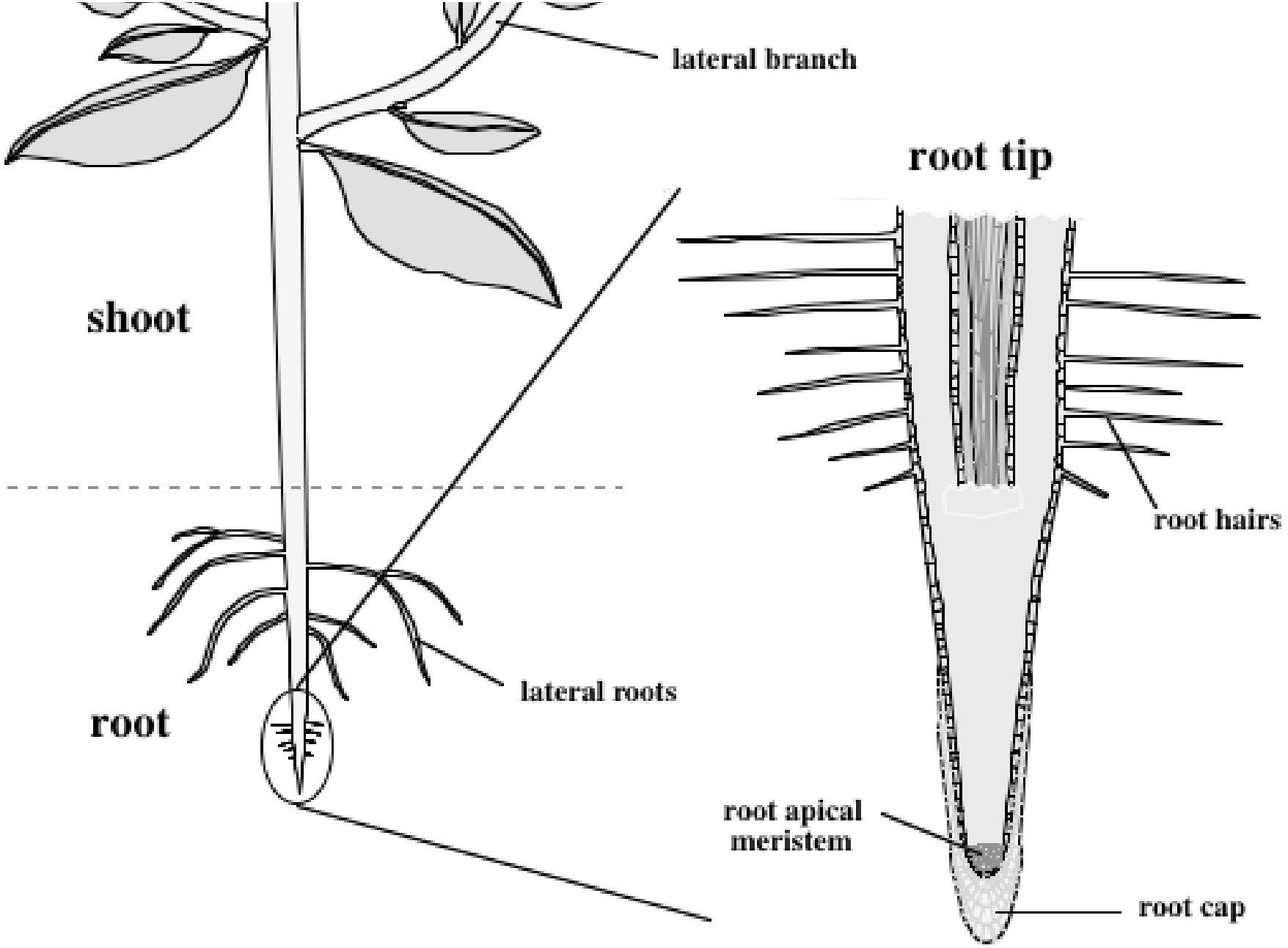
Meristems - actively growing regions of plant

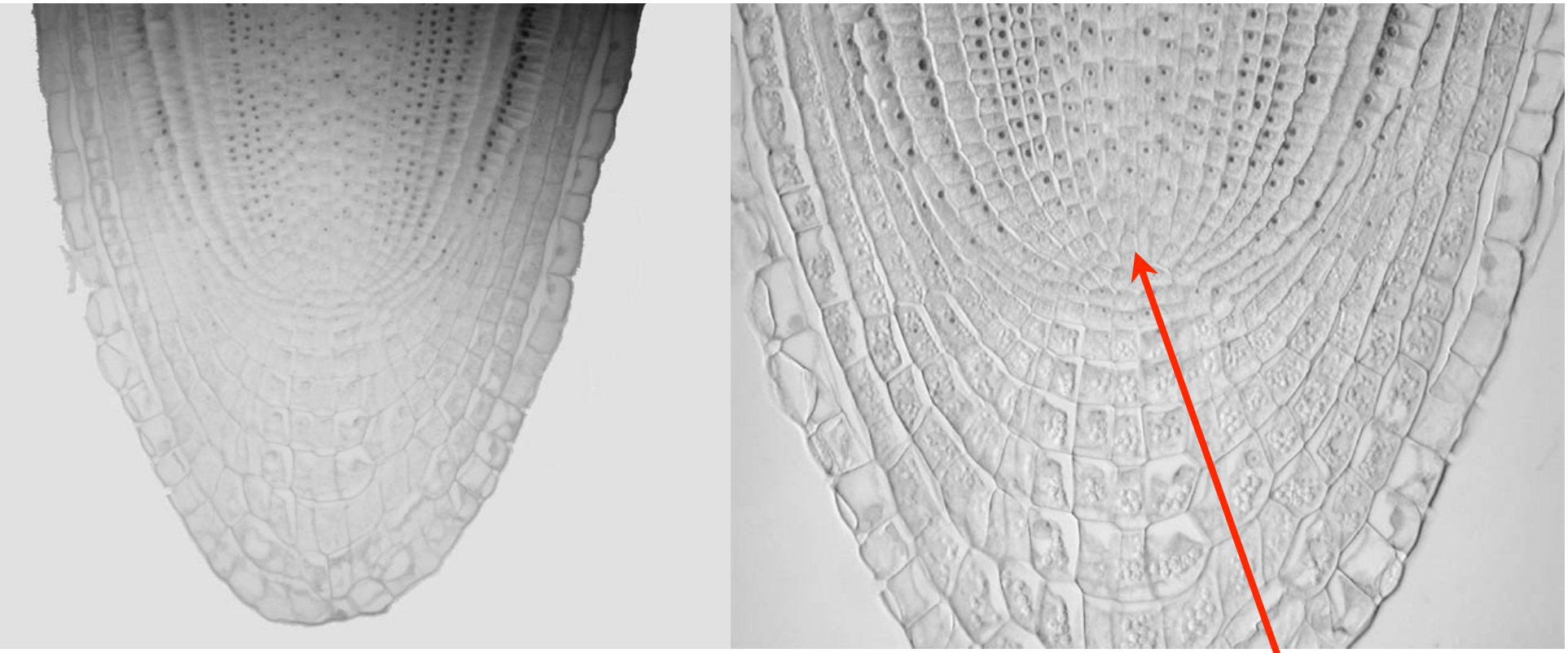
- Primary meristems
  - Root apical meristems
  - Shoot apical meristems

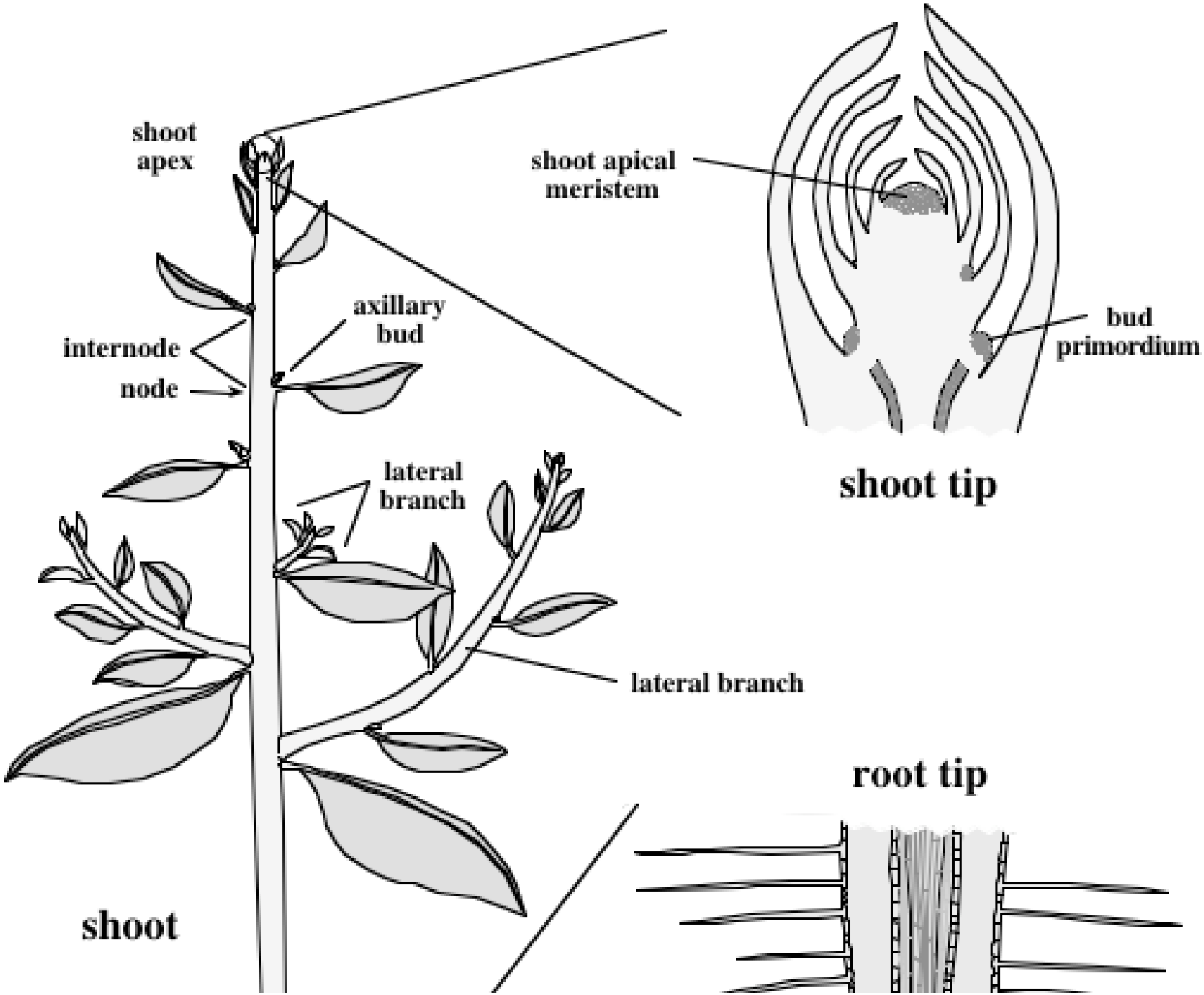
Meristems

- cell division
- cell elongation
- cell differentiation

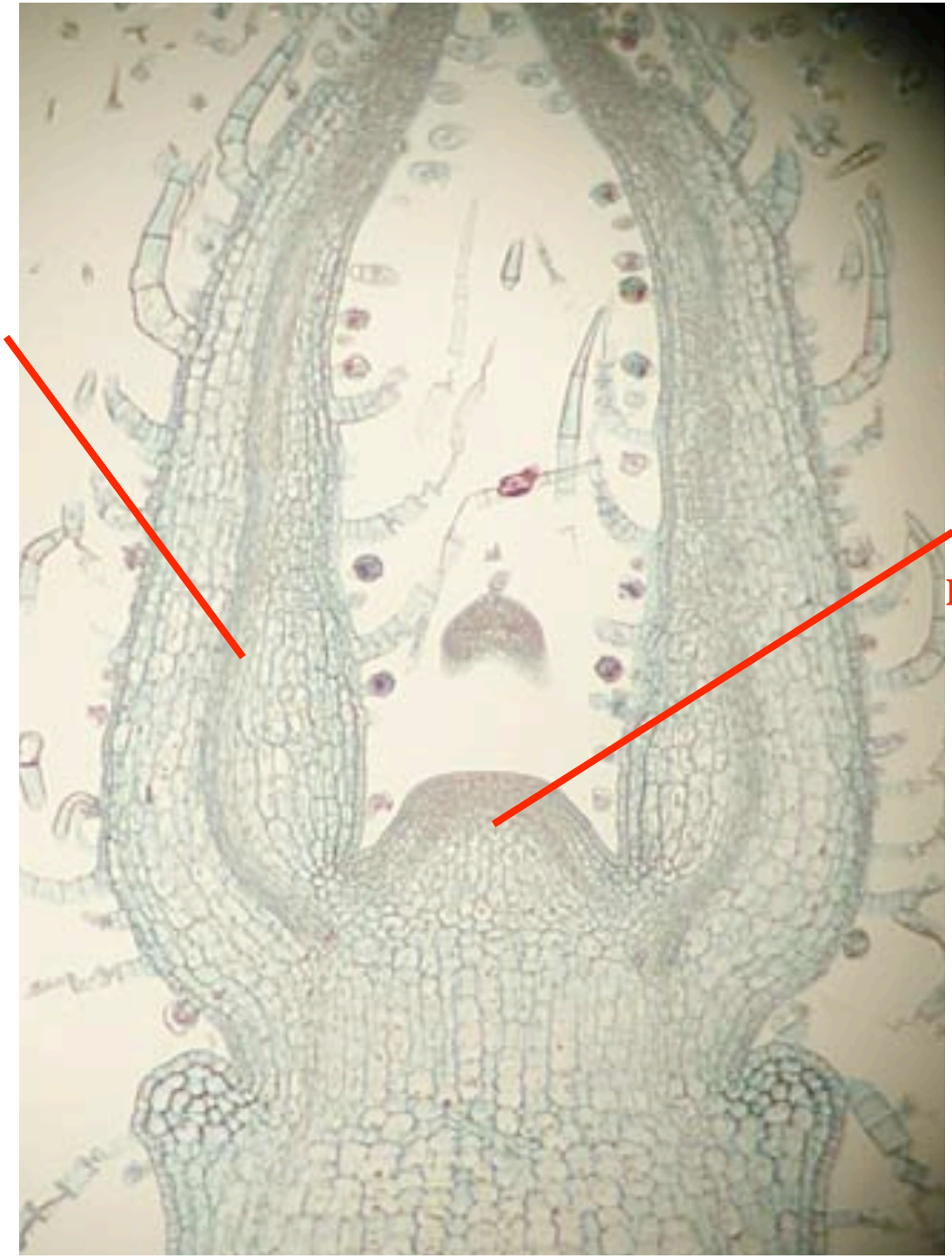

shoot apex
shoot apical meristem
axillary bud
internode
node
bud primordium
shoot tip
lateral branch
lateral branch
root tip
shoot
root hairs
lateral roots
root
root apical meristem
root cap


lateral branch
root tip
shoot
root hairs
lateral roots
root
root apical meristem
root cap


root apical
meristem

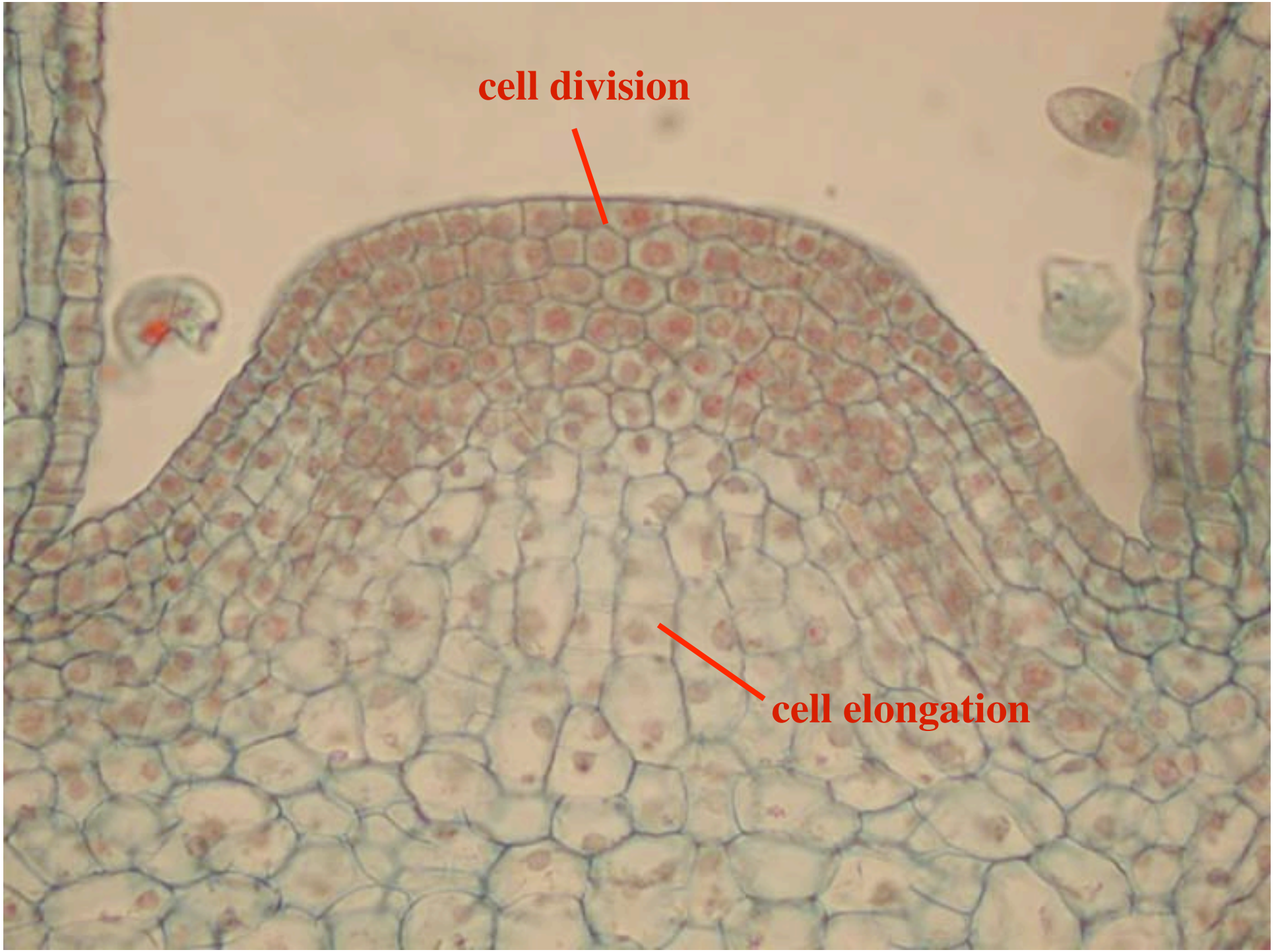

shoot
apex
axillary
bud
internode
node
lateral
branch
lateral branch
shoot
shoot apical
meristem
bud
primordium
shoot tip
root tip

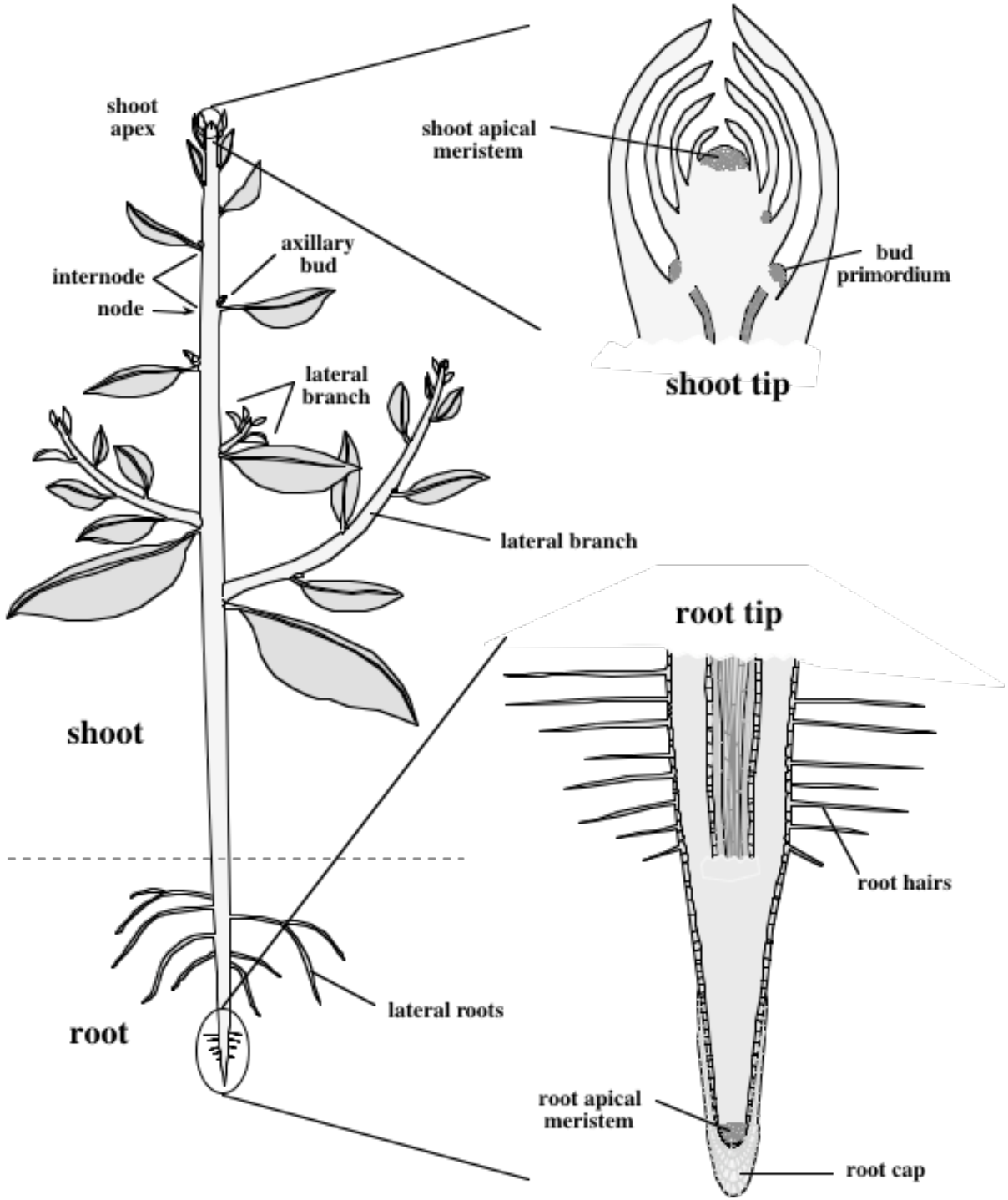
leaf primordium



apical meristem

SHOOT


cell division
cell elongation


shoot apex
shoot apical meristem
axillary bud
internode
node
bud primordium
shoot tip
lateral branch
lateral branch
root tip
shoot
root hairs
lateral roots
root
root apical meristem
root cap

Cell differentiation

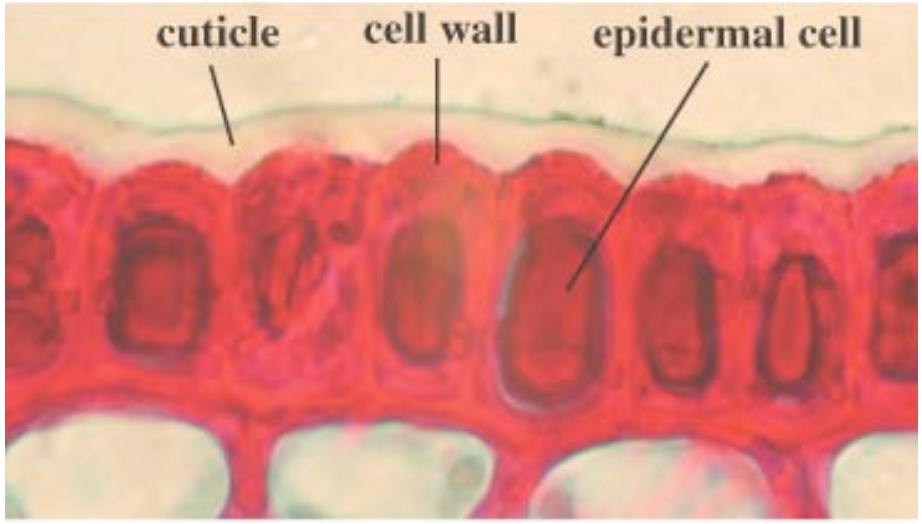
Results in different cell and tissue types

Tissue = 1 or more cell types having a common origin or function

Epidermal cell

- outer layer of all plant organs
- in land plants, protected by outer **cuticle**
    - cuticle helps to prevent dessication

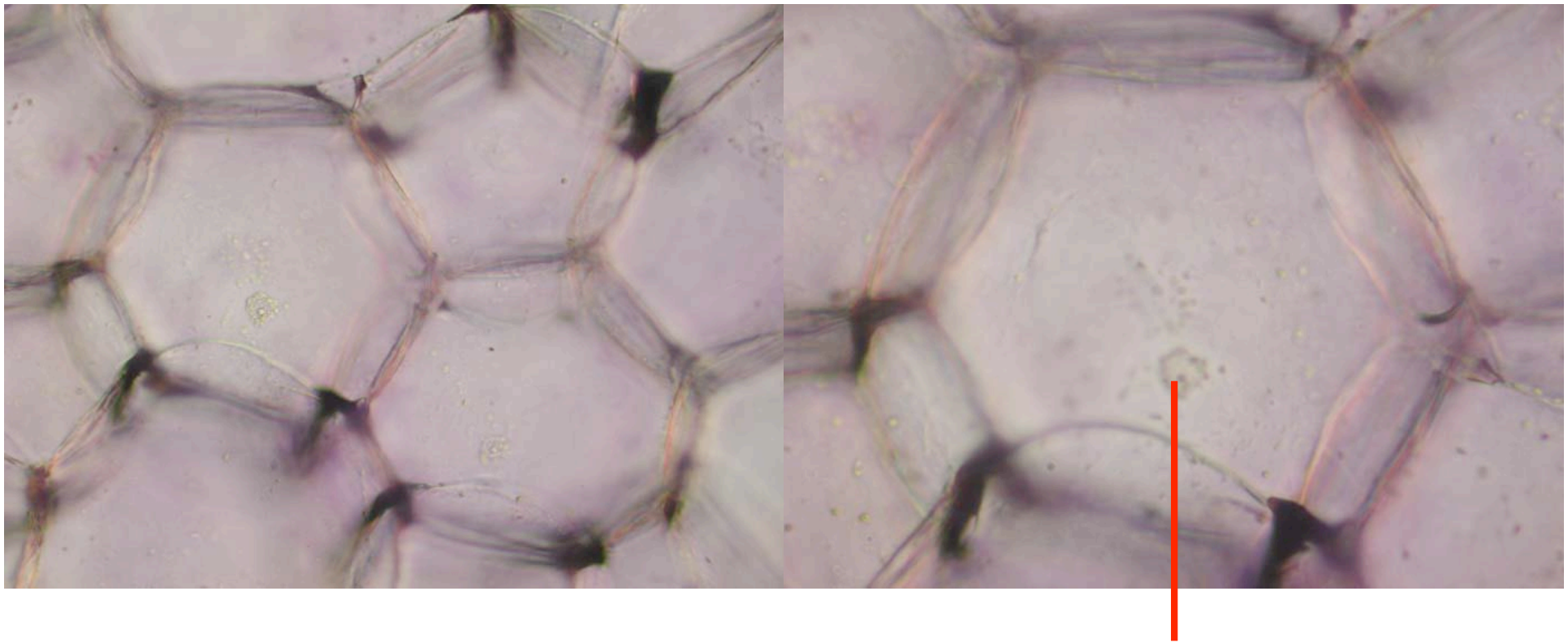
cuticle - protective layer on outside
- helps prevent water loss



parenchyma

- - living at maturity
- - involved in metabolic reactions

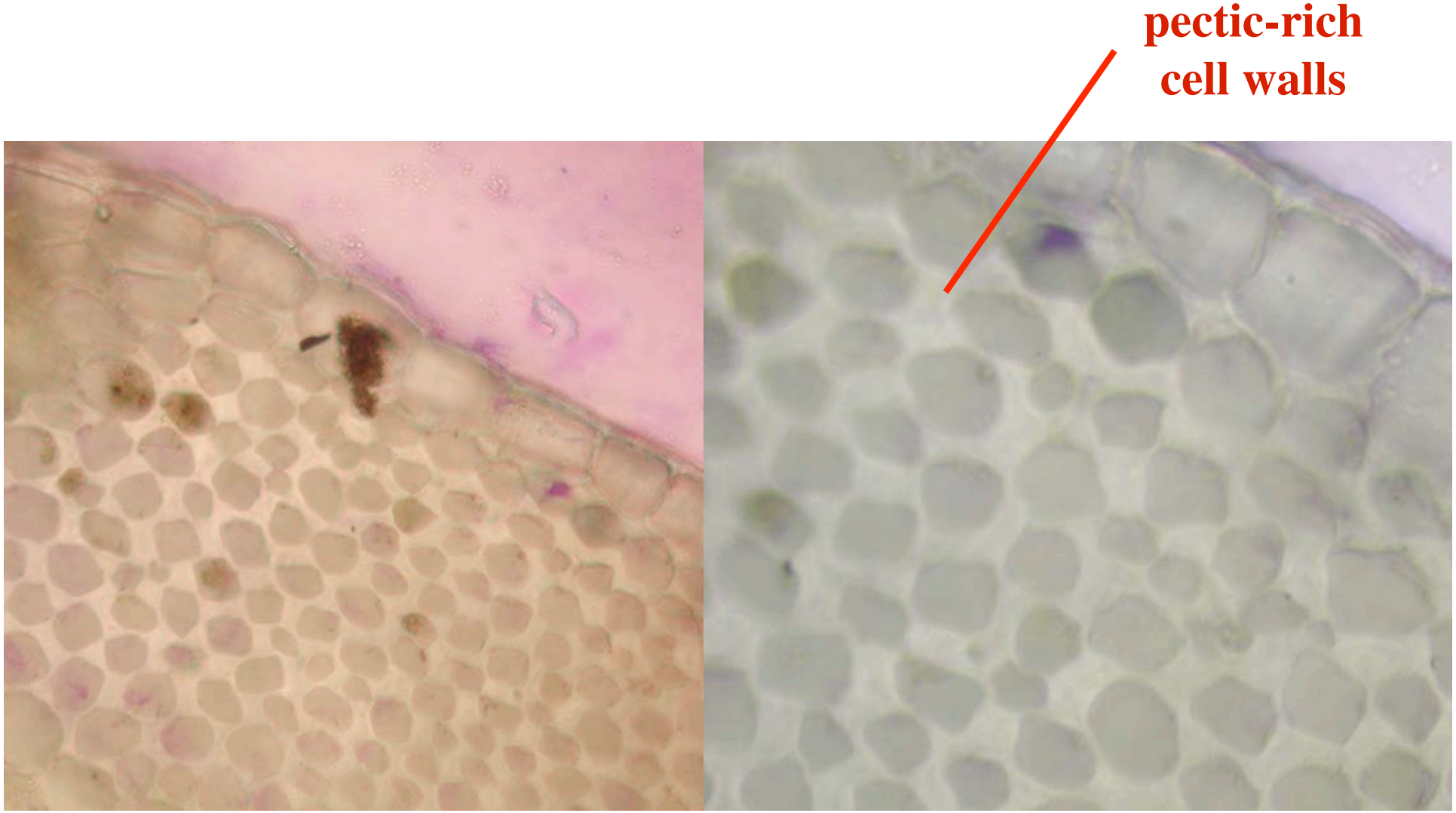
parenchyma



collenchyma

- - cells living, elongate
- - cell walls unevenly thickened,
  rich in **pectins** [pectin - complex polysaccaride,
  mainly of galacturonic acid units]
- - functions in structural support
  (while stem is still elongating)

collenchyma



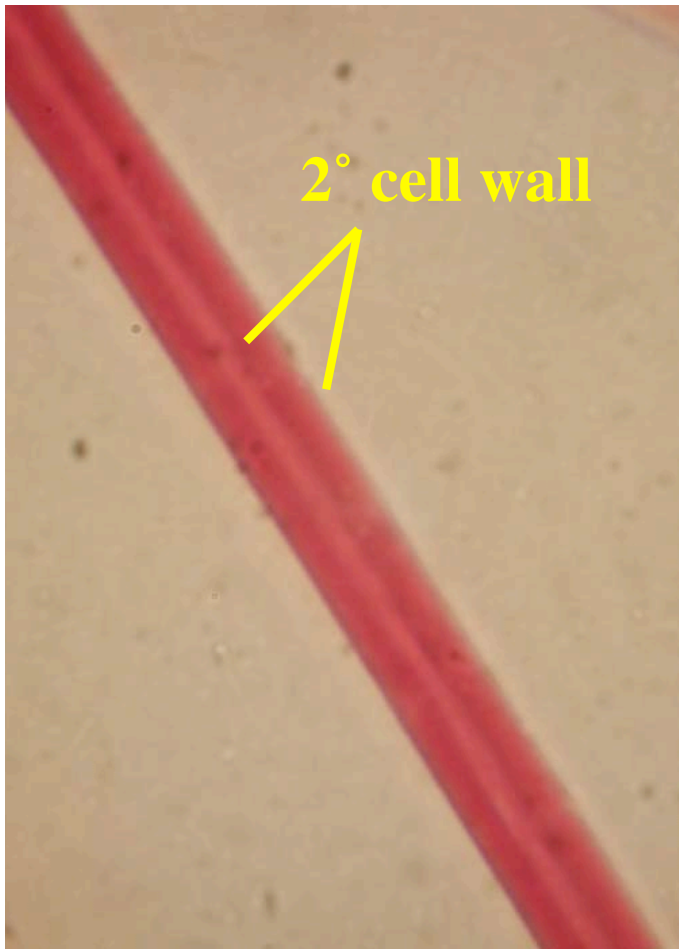
sclerenchyma

- cells dead at maturity
- thick, secondary, lignified cell walls
- functions in structural support

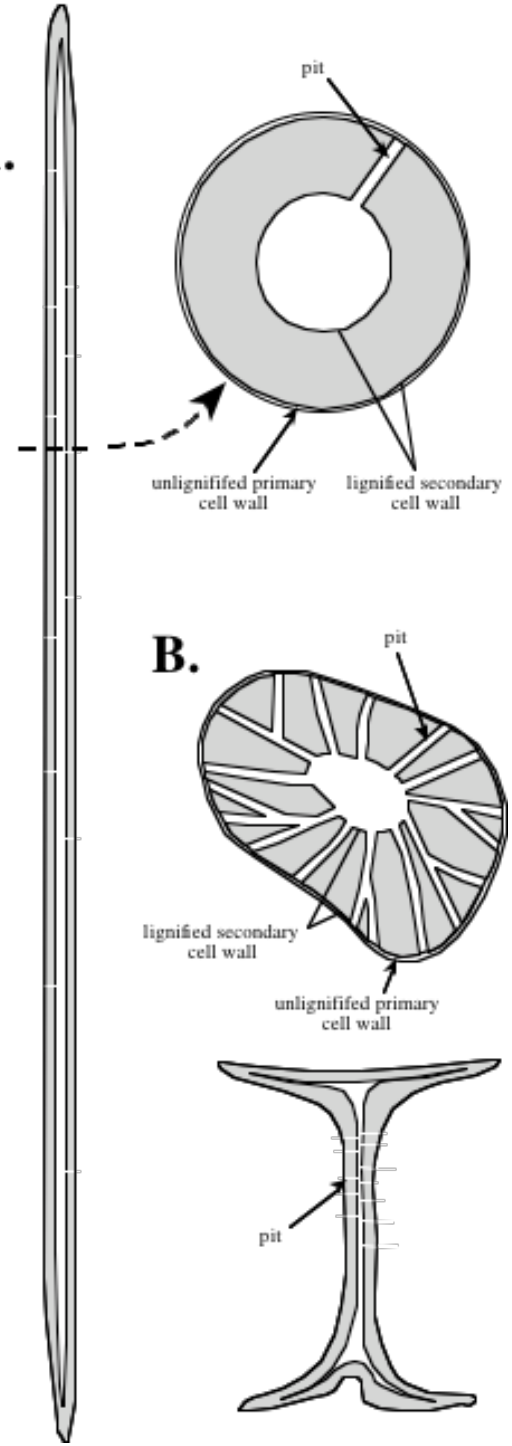
2 cell types:

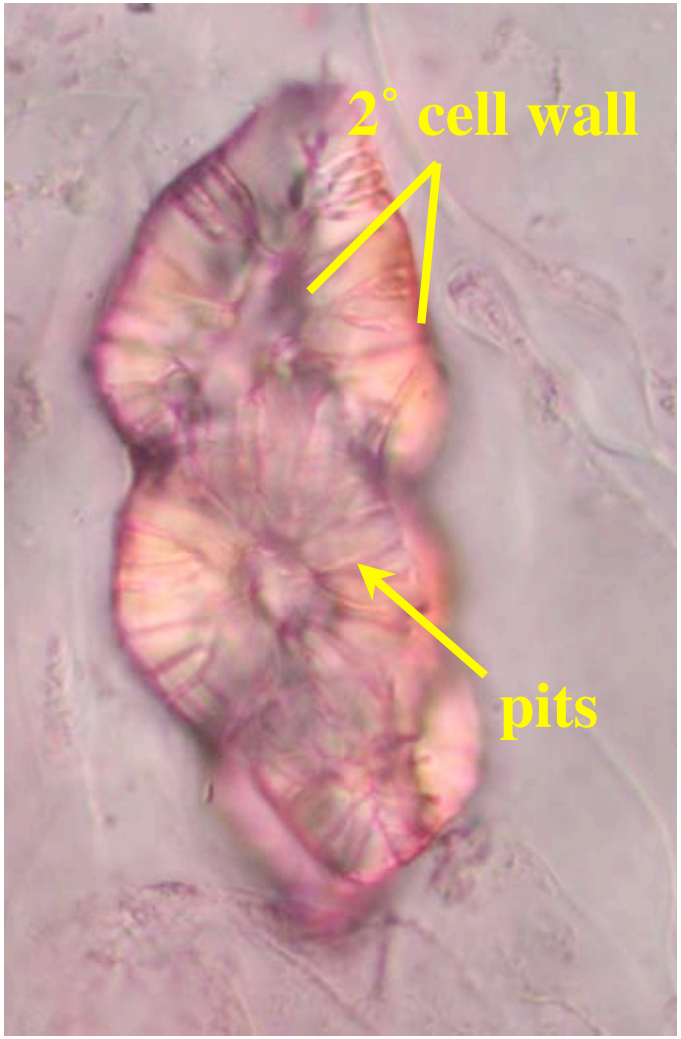
fibers - very long, thin, tapered

sclereids - variable in shape, mostly isodiametric



a) fiber





b) sclereids

xylem

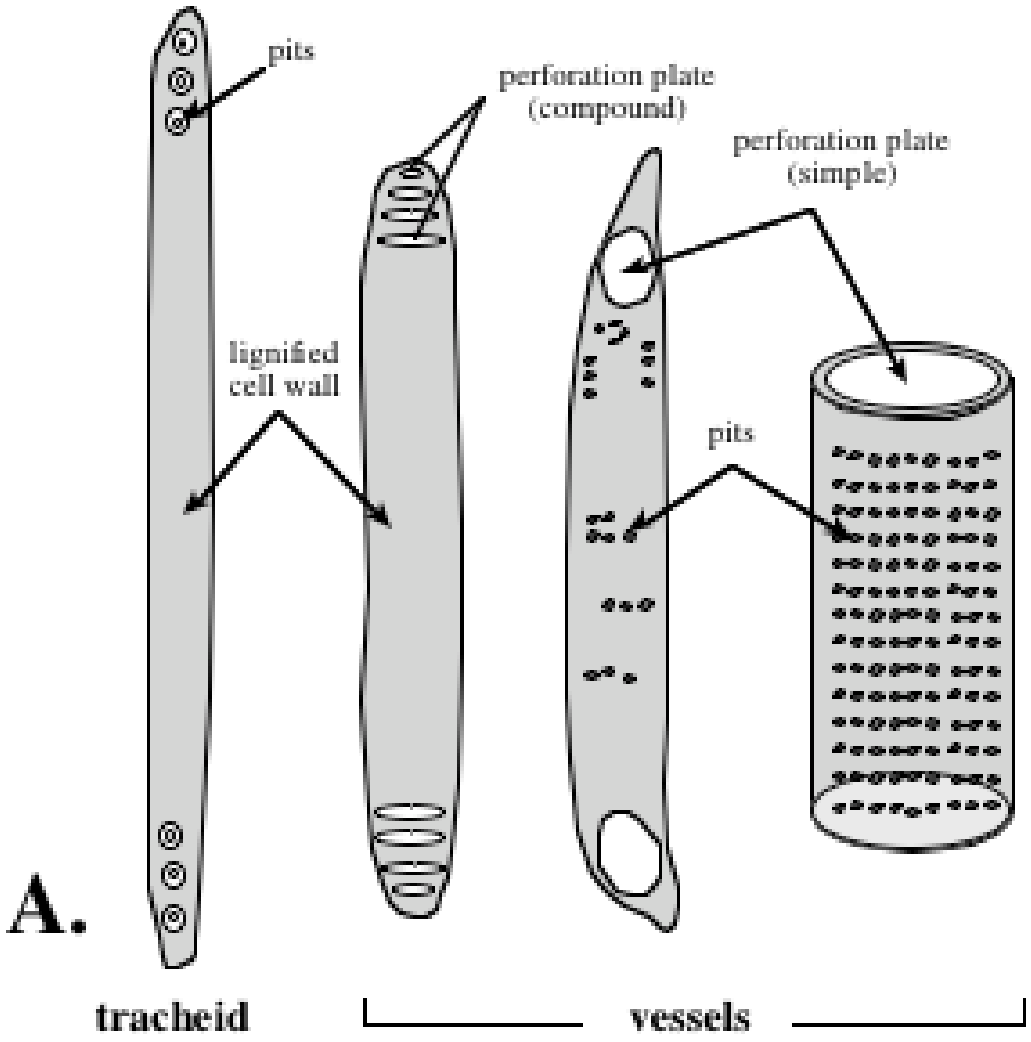
- -function: conduction of water and minerals
- -consists of:
  - parenchyma
  - fibers
  - **tracheary elements** (2 types: tracheids and vessels)

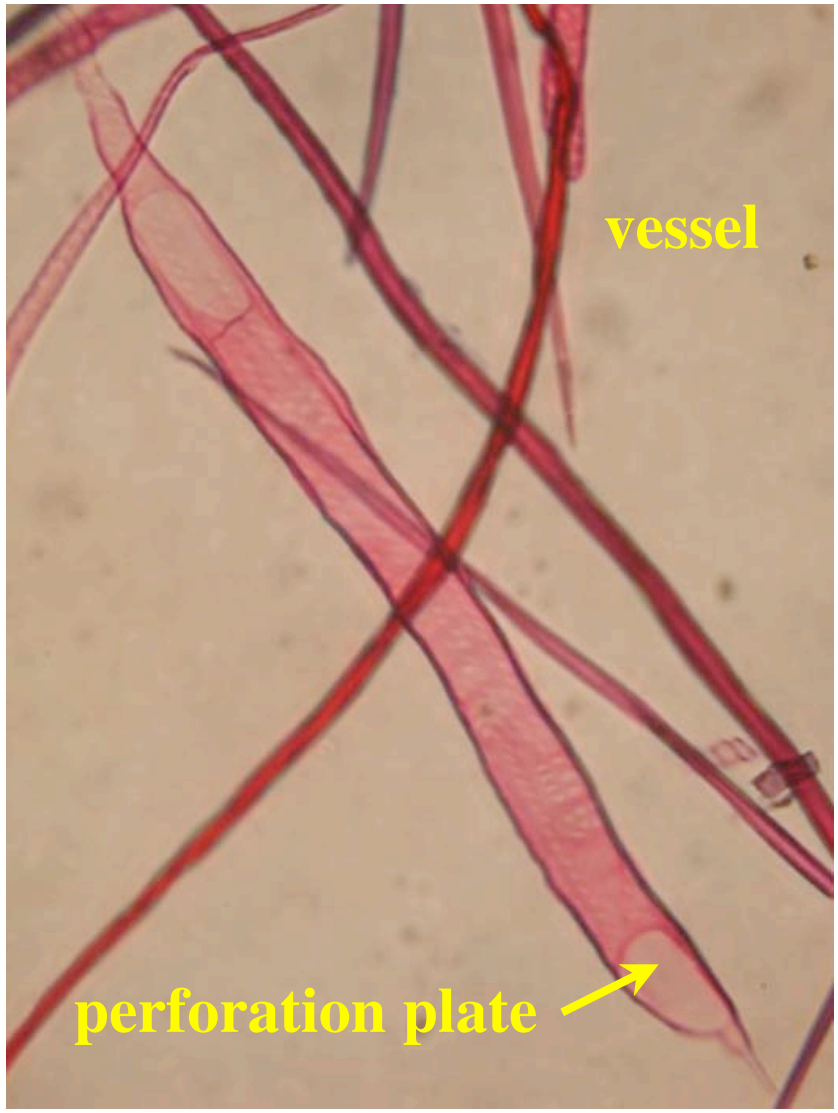
    actual conductive cells

    dead at maturity

    joined end to end, form pipe-like conduits

    lignified secondary cell walls with pits


pits
perforation plate
(compound)
perforation plate
(simple)
lignified
cell wall
pits
A.
tracheid
vessels


vessel
perforation plate

phloem

-function: conduction of sugars

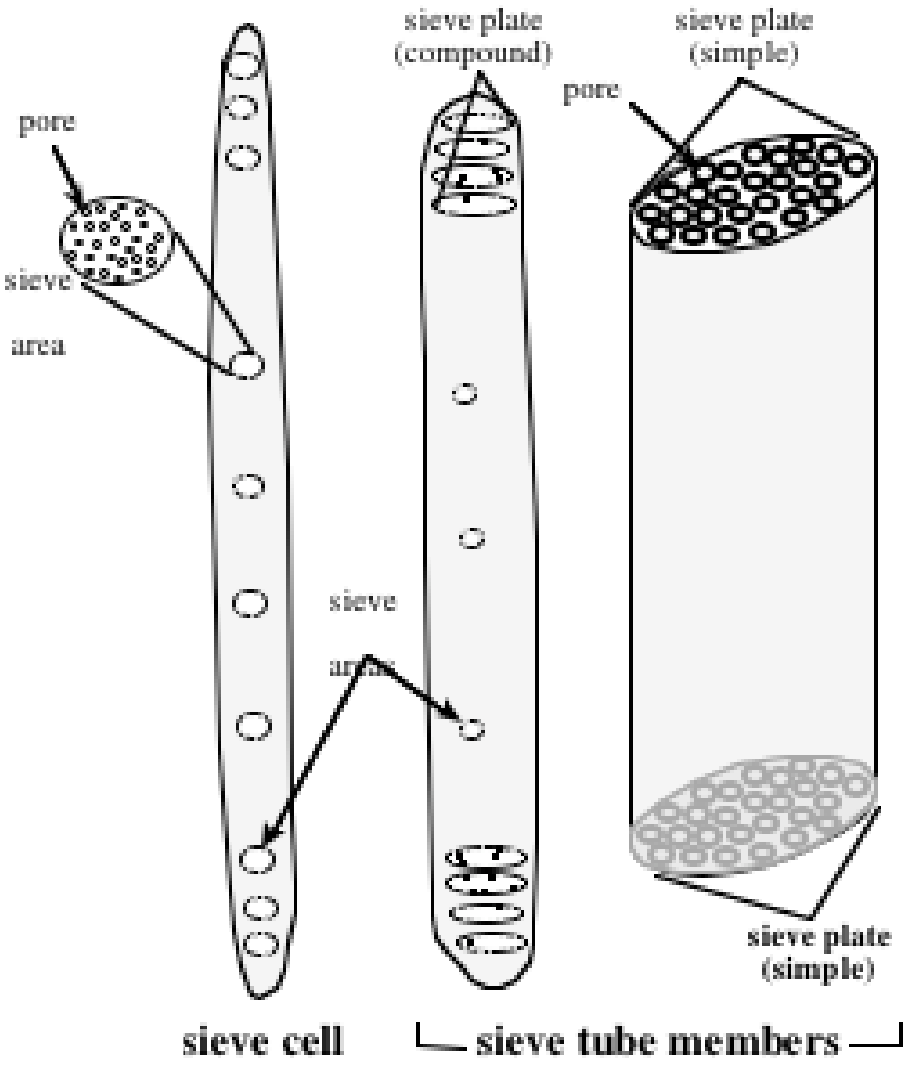
-consists of:

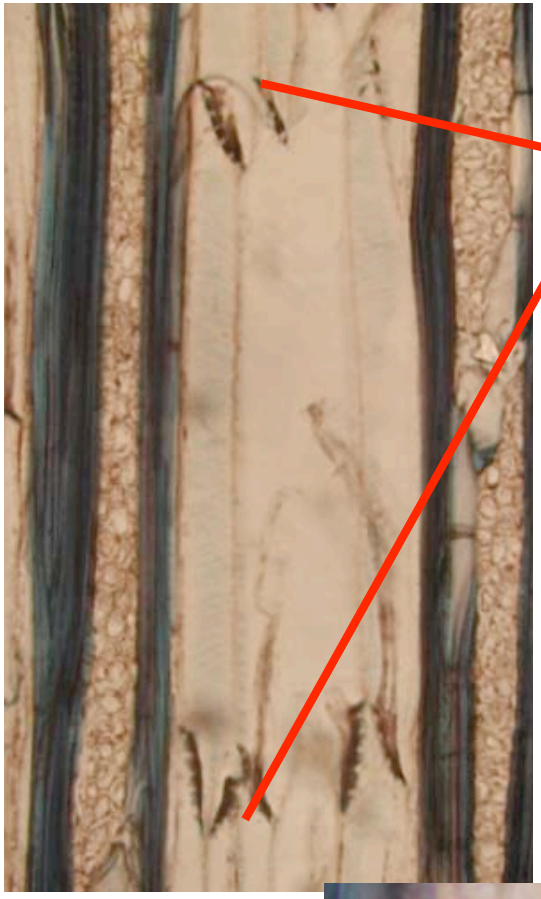
parenchyma

fibers

sieve elements (2 types: sieve cells or sieve tube members)

- actual sugar-conductive cells
- semi-live at maturity (lose nuclei, but have cytoplasm)
- primary cell-wall only
- have callose-lined pores (making up a sieve plate or sieve area), through which sugar sol. passes

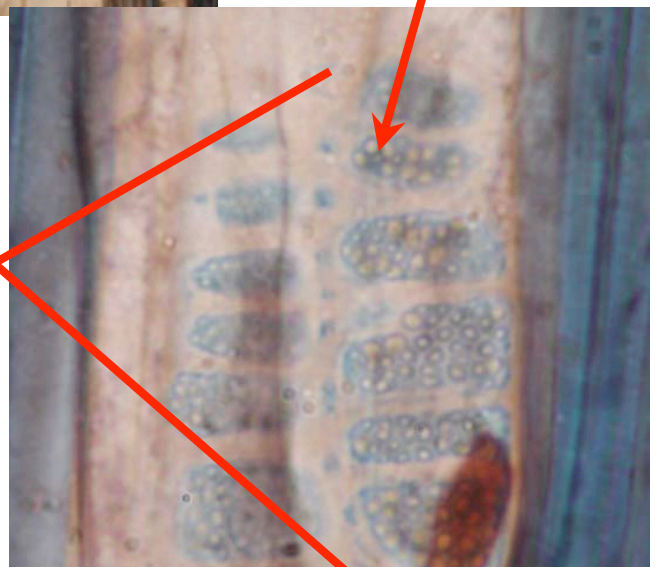




sieve tube member

callose-lined pore

sieve plate



Plant organs

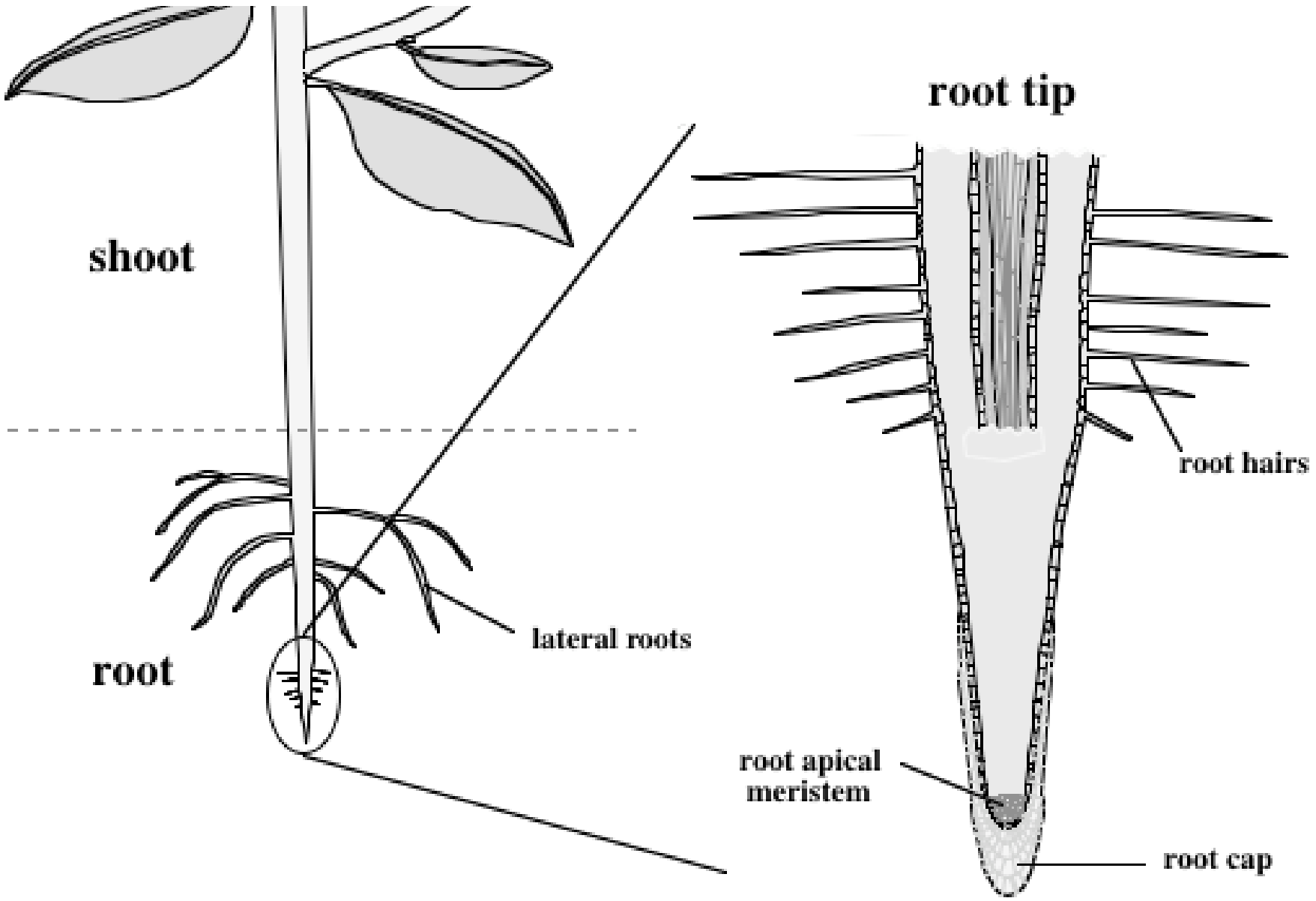
root - absorptive, anchoring, storage organ

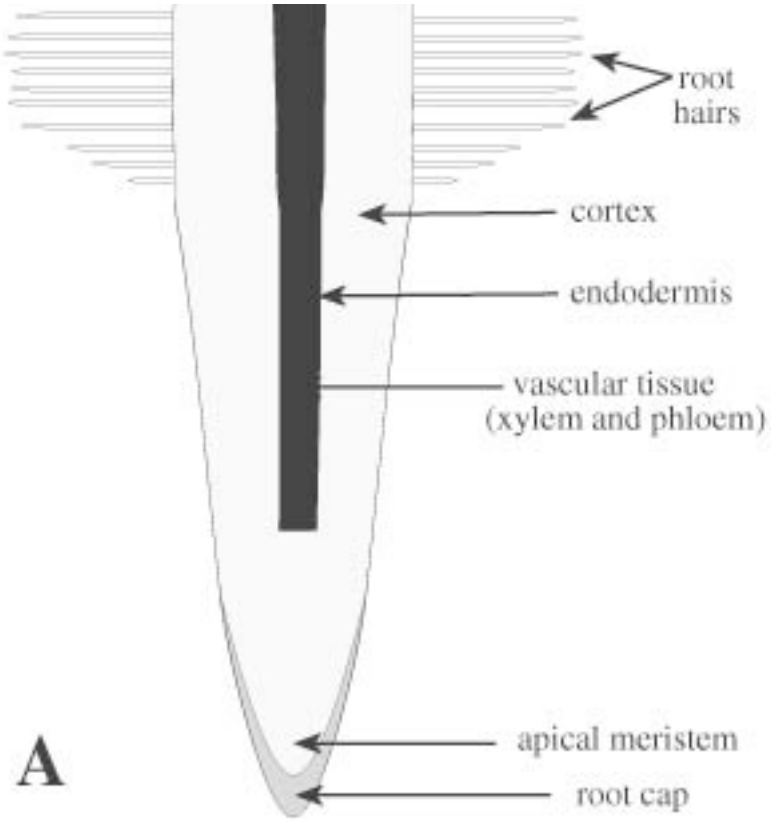
shoot = stem + associated leaves

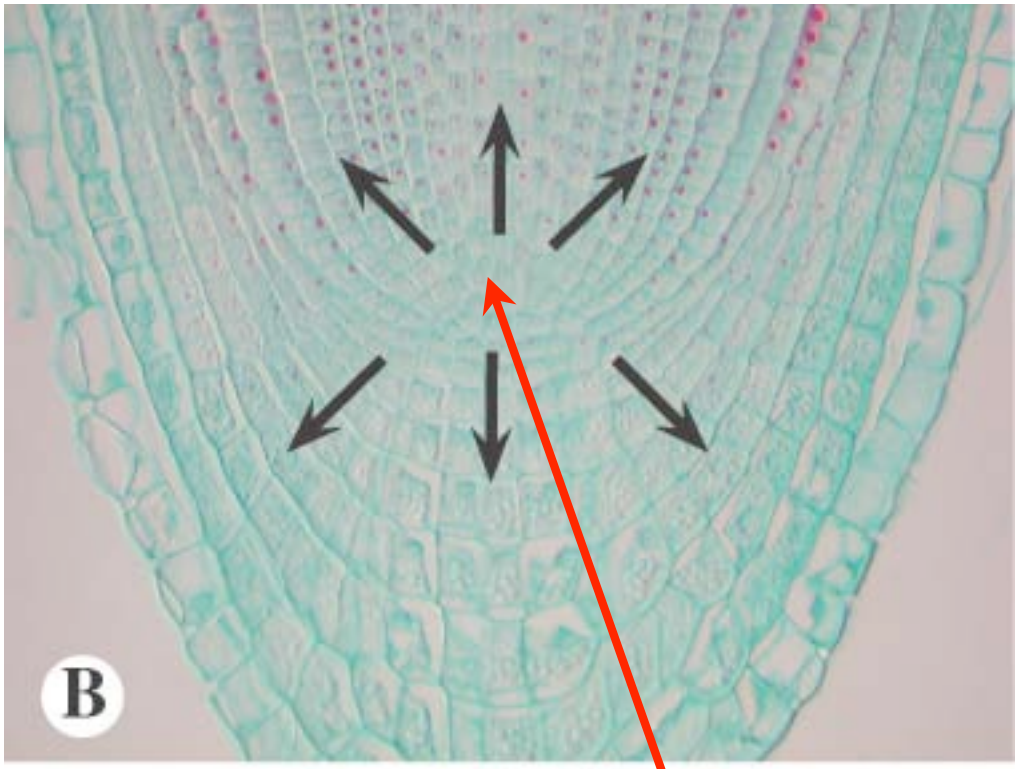
stem - conductive, supportive, storage organ

leaf - photosynthetic organ

bud = immature shoot, gen. arising from leaf axile; ---> lateral branch


shoot
root
lateral roots
root tip
root hairs
root apical meristem
root cap

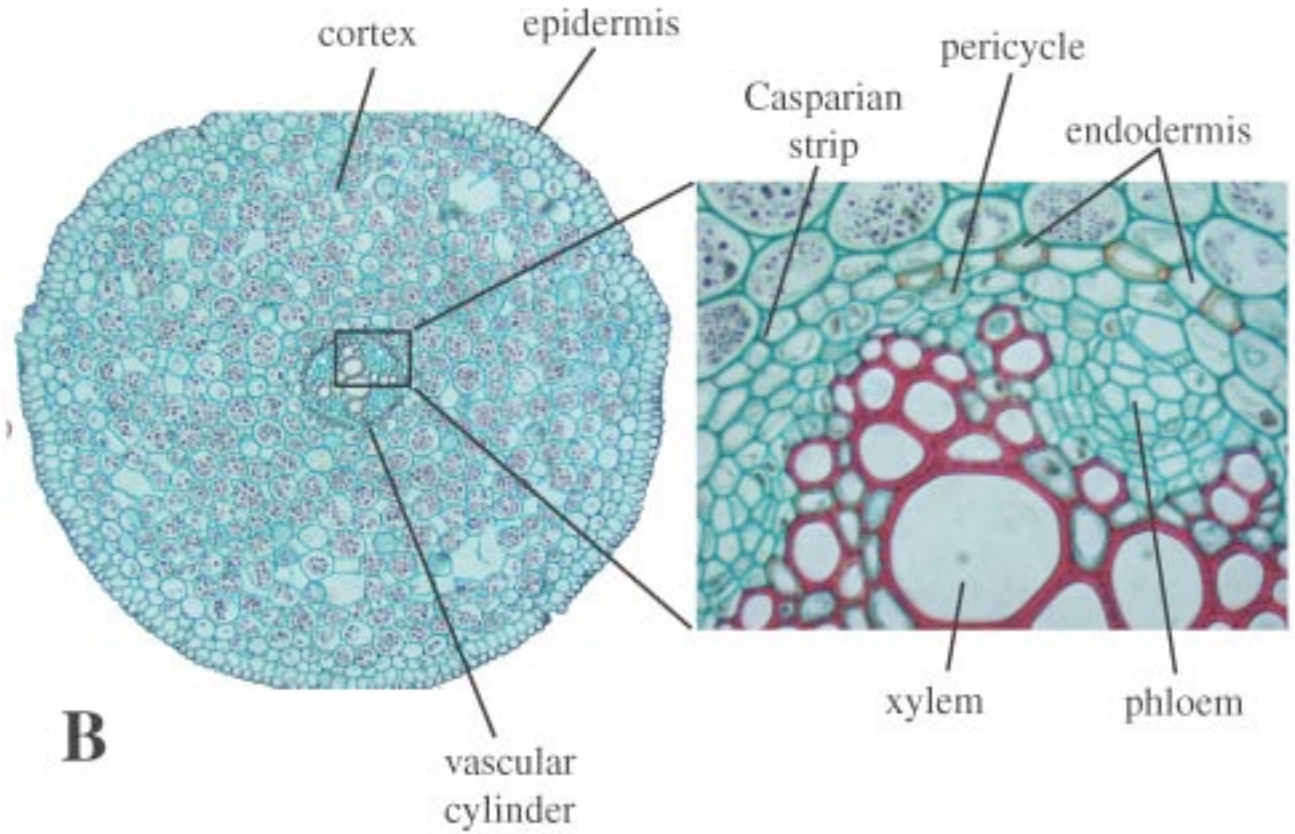




root apical meristem

ROOT (l.s.)

1) Protective root cap
2) Absorptive root hairs



ROOT (c.s.)

3) Give rise to new roots endogenously (from within)

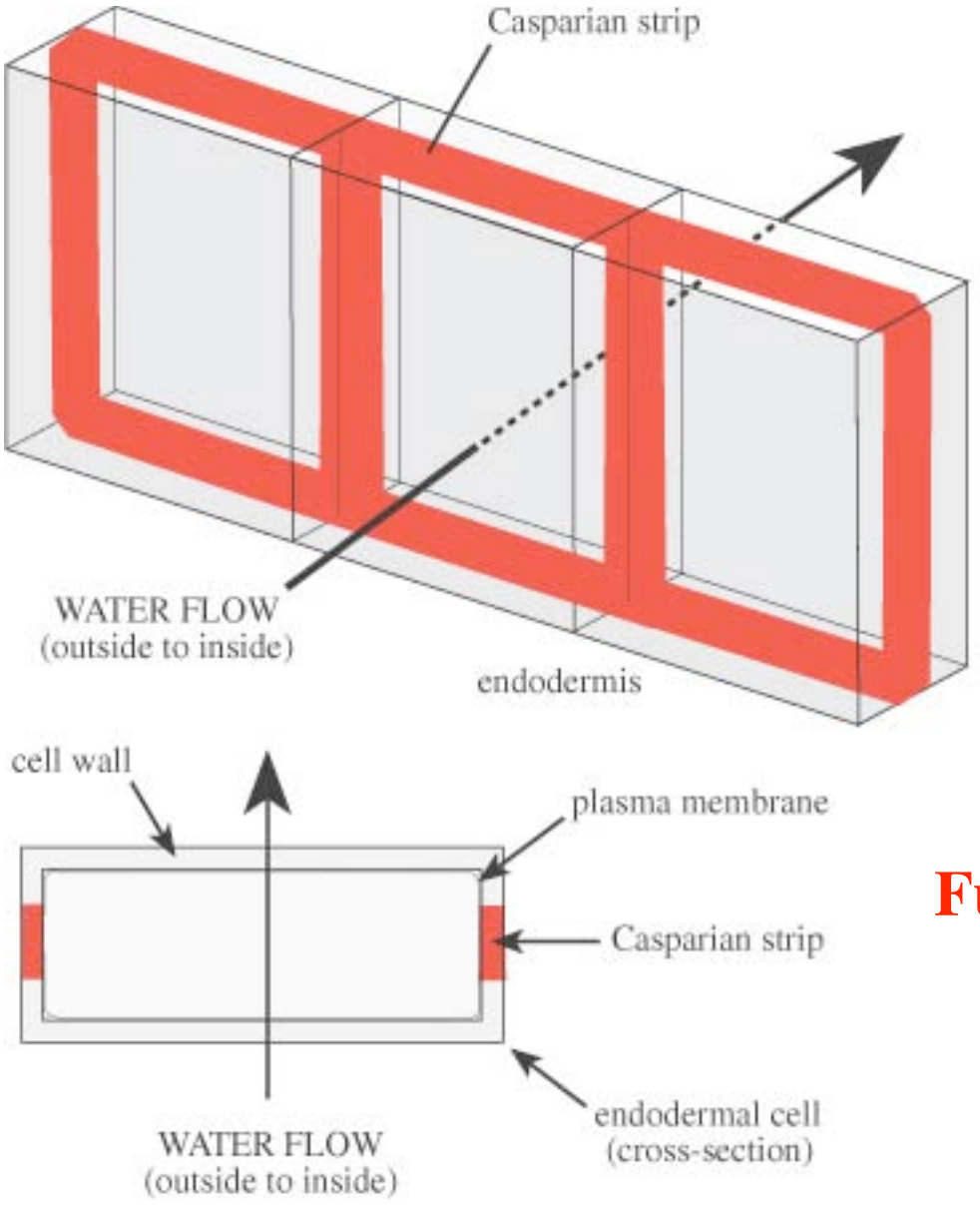
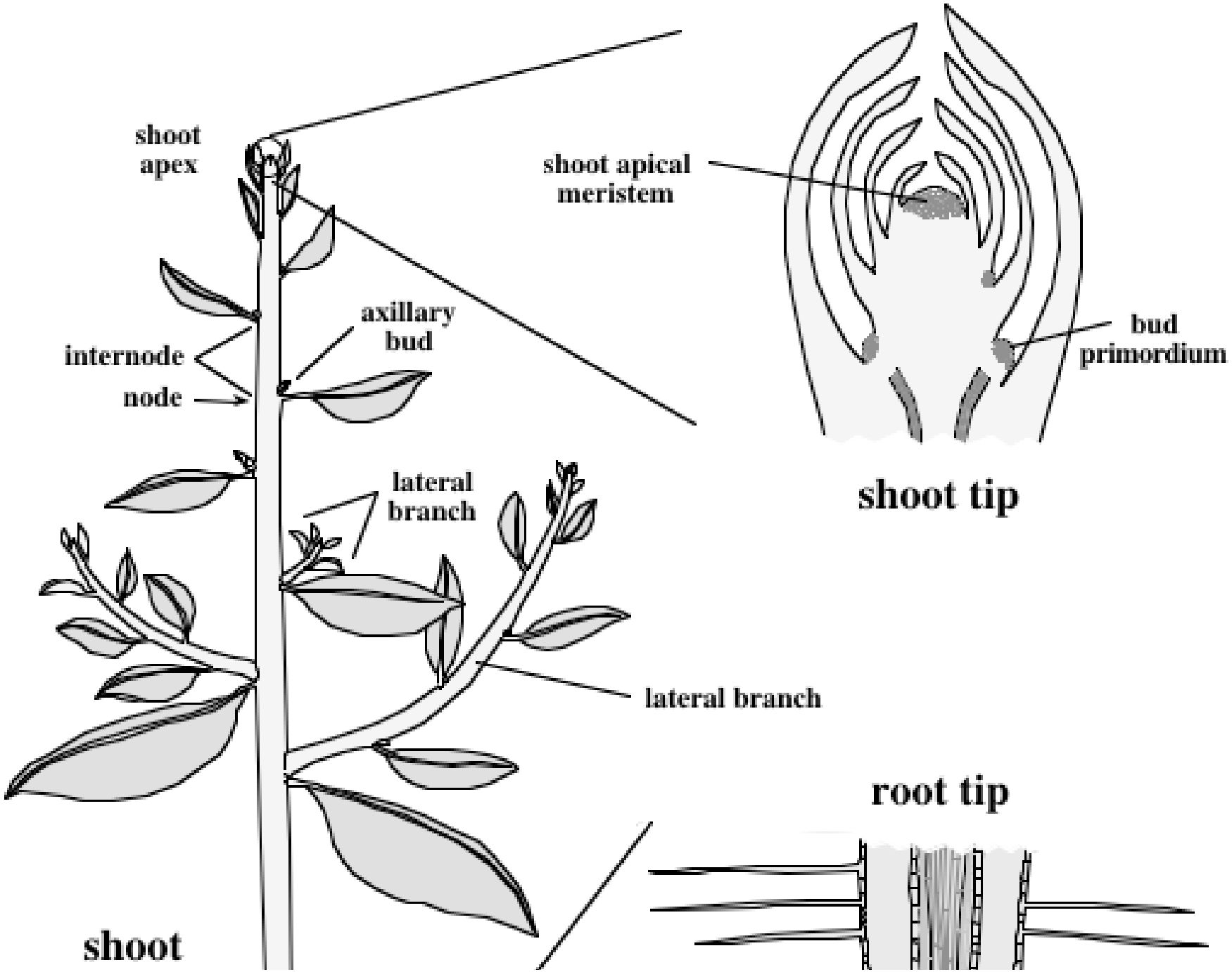


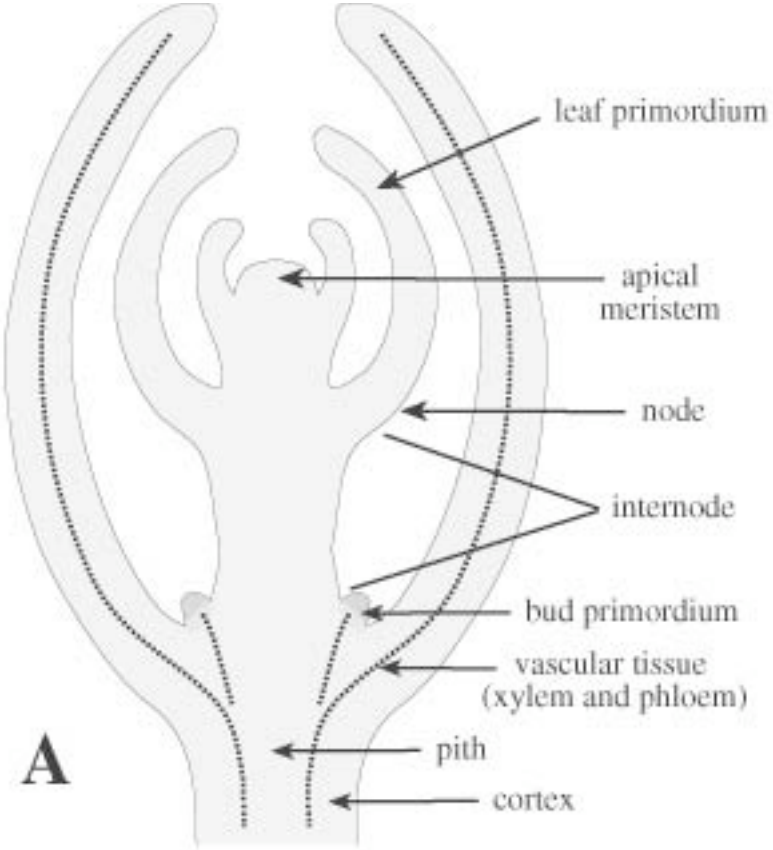
Figure 10.13 The Casparian strip, a specialized feature of cells of the endodermis.

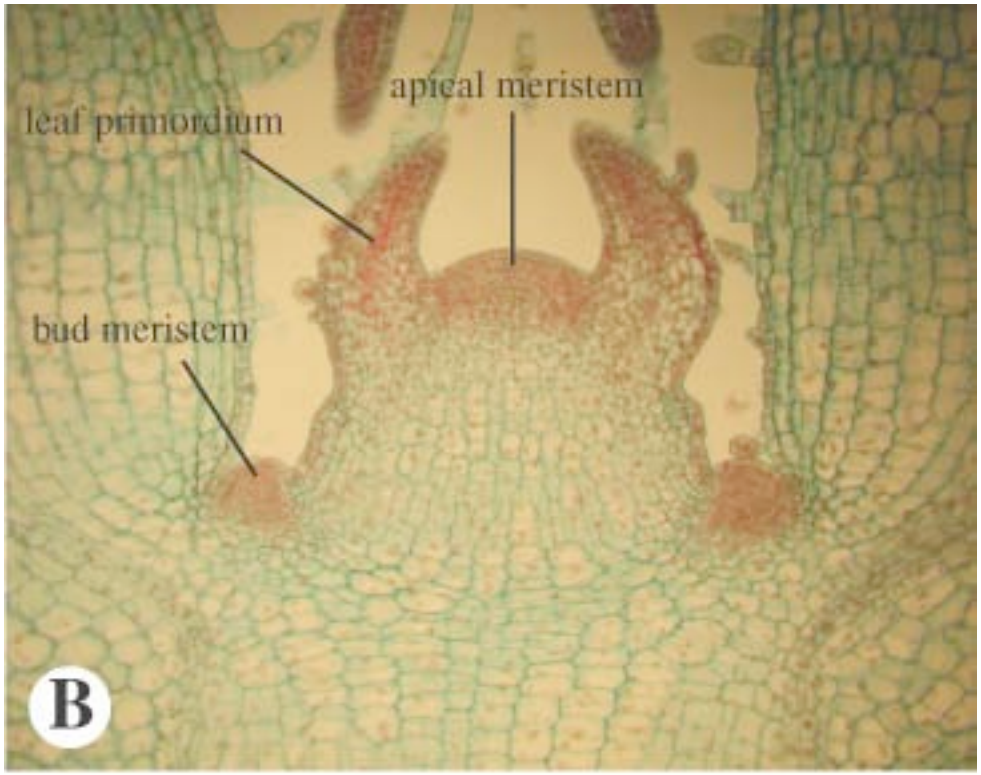
Casparian Strip

Function: forces fluids from outside through plasma membrane = selective absorption

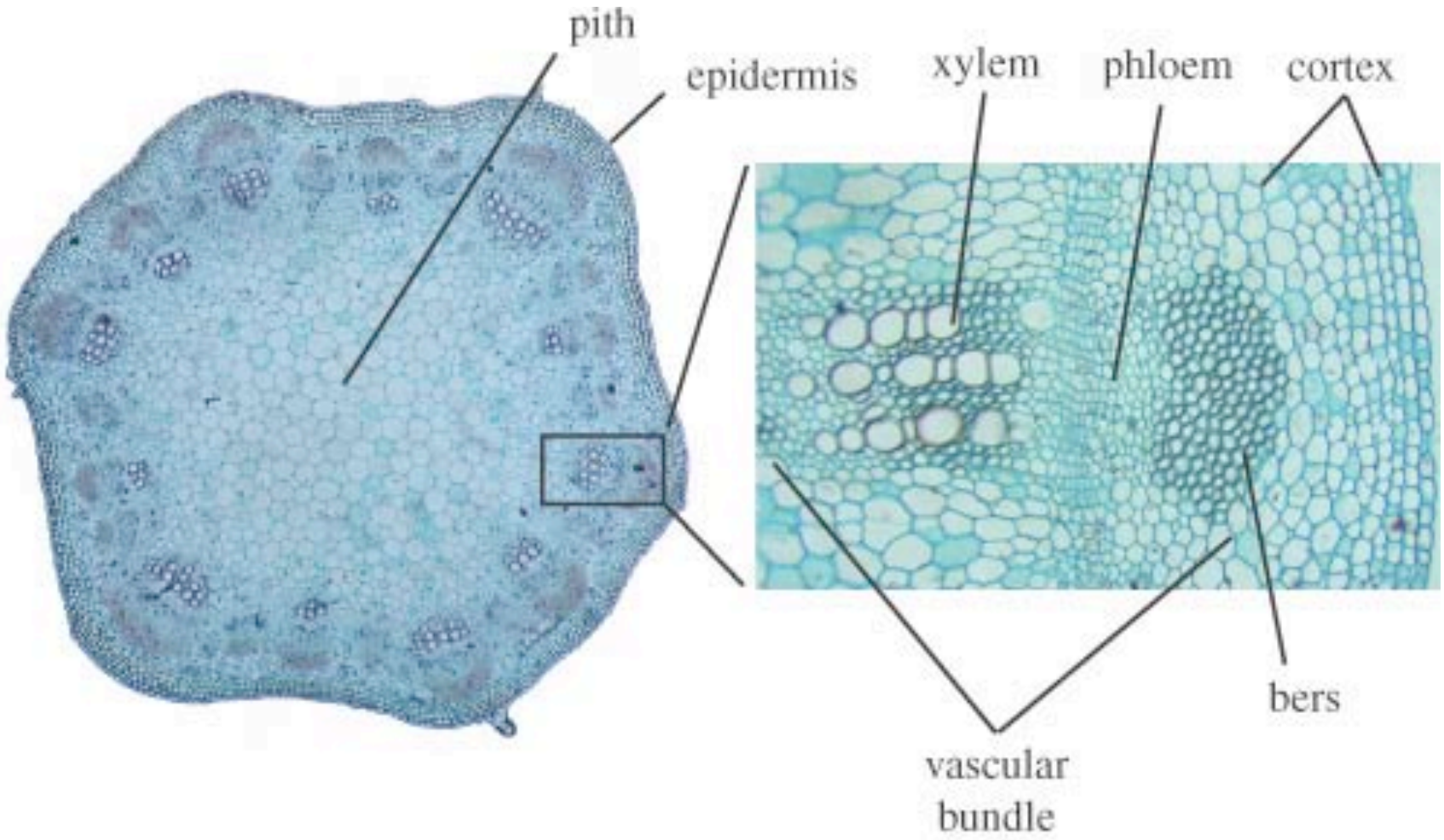

shoot
apex
axillary
bud
internode
node
lateral
branch
lateral branch
shoot
shoot apical
meristem
bud
primordium
shoot tip
root tip

SPOROPHYTIC SHOOT





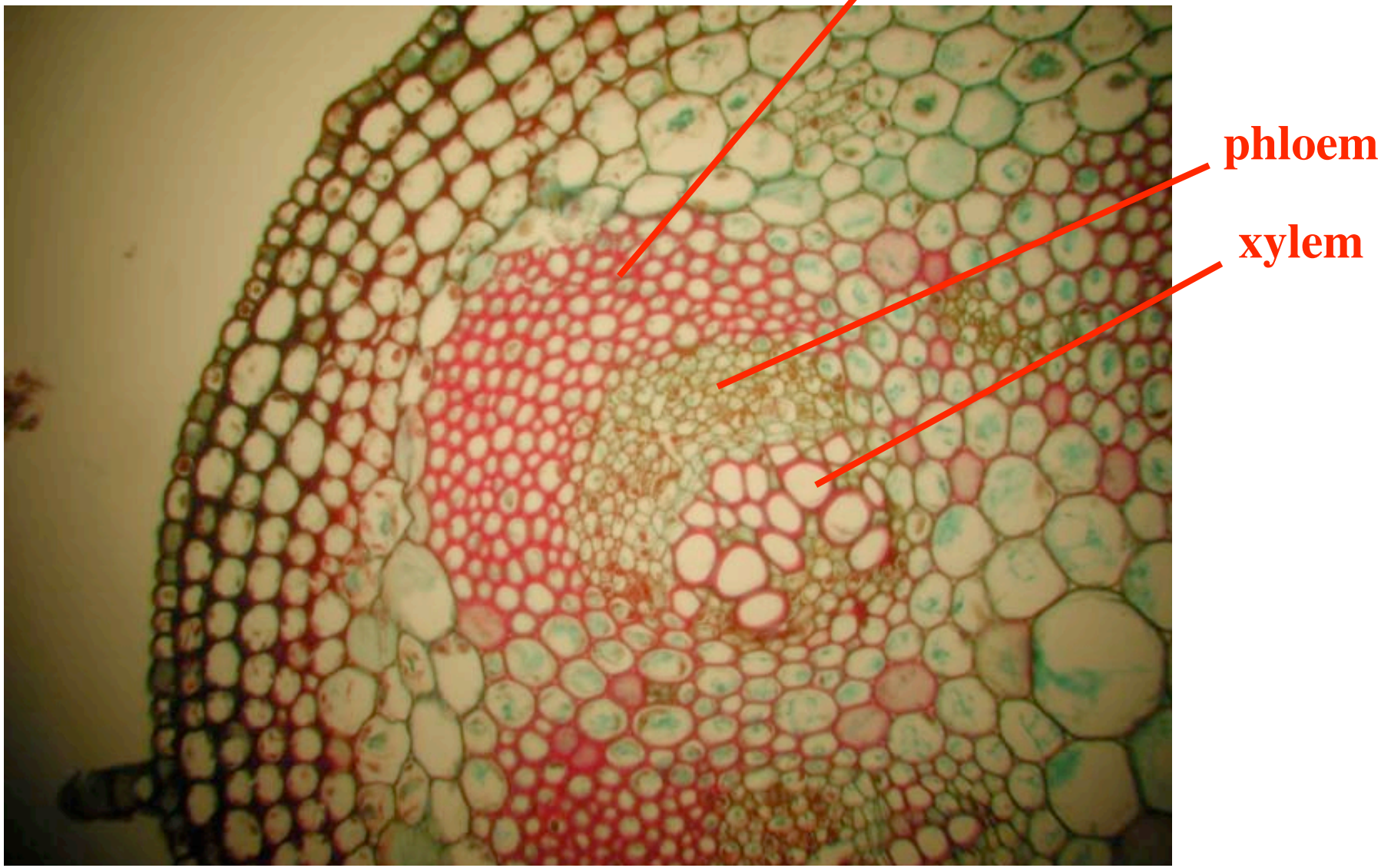
STEM - has discrete vascular bundles (xylem & phloem)



STEM (of Eudicot)

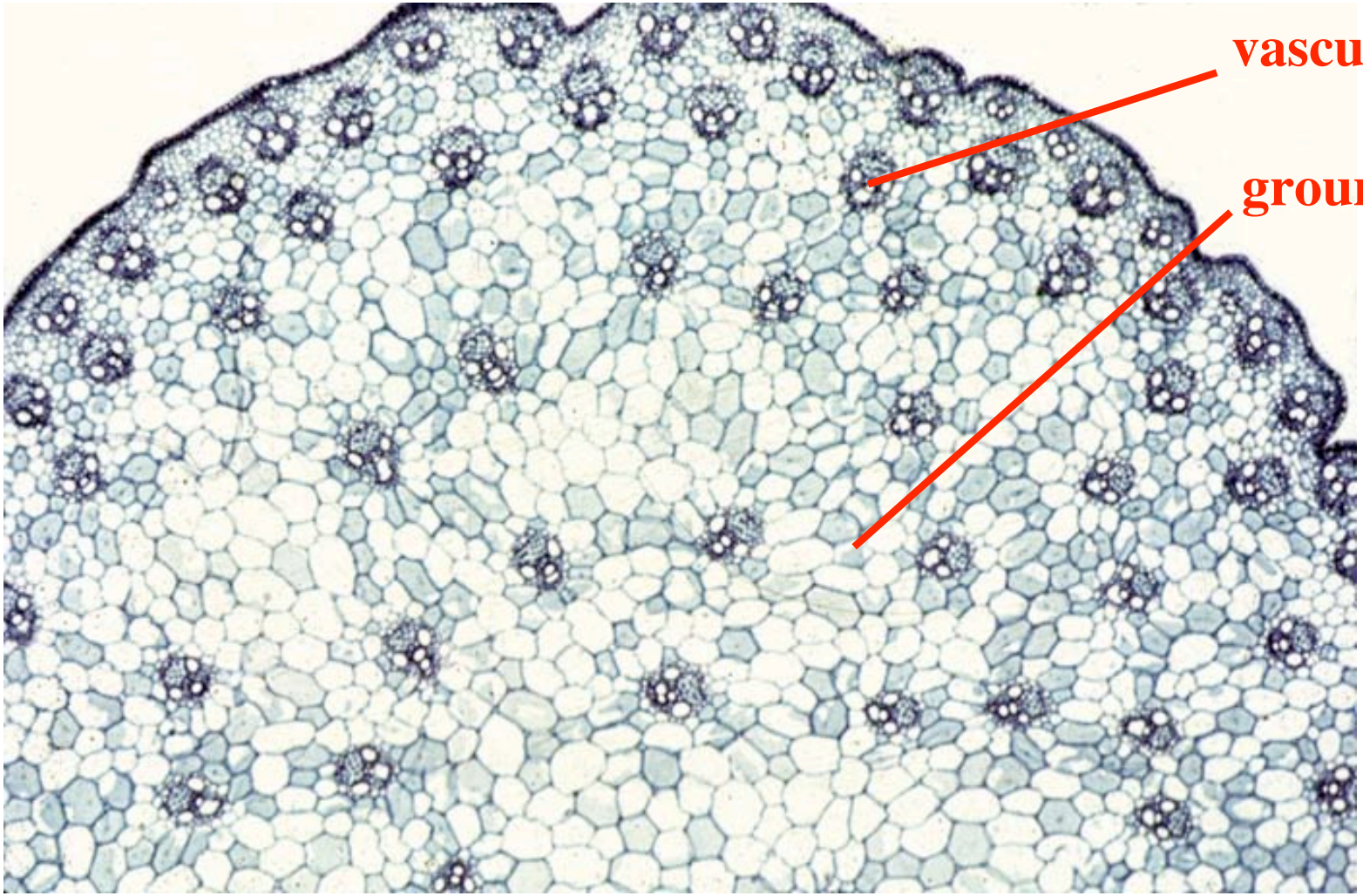
-bundles in a single ring

STEM

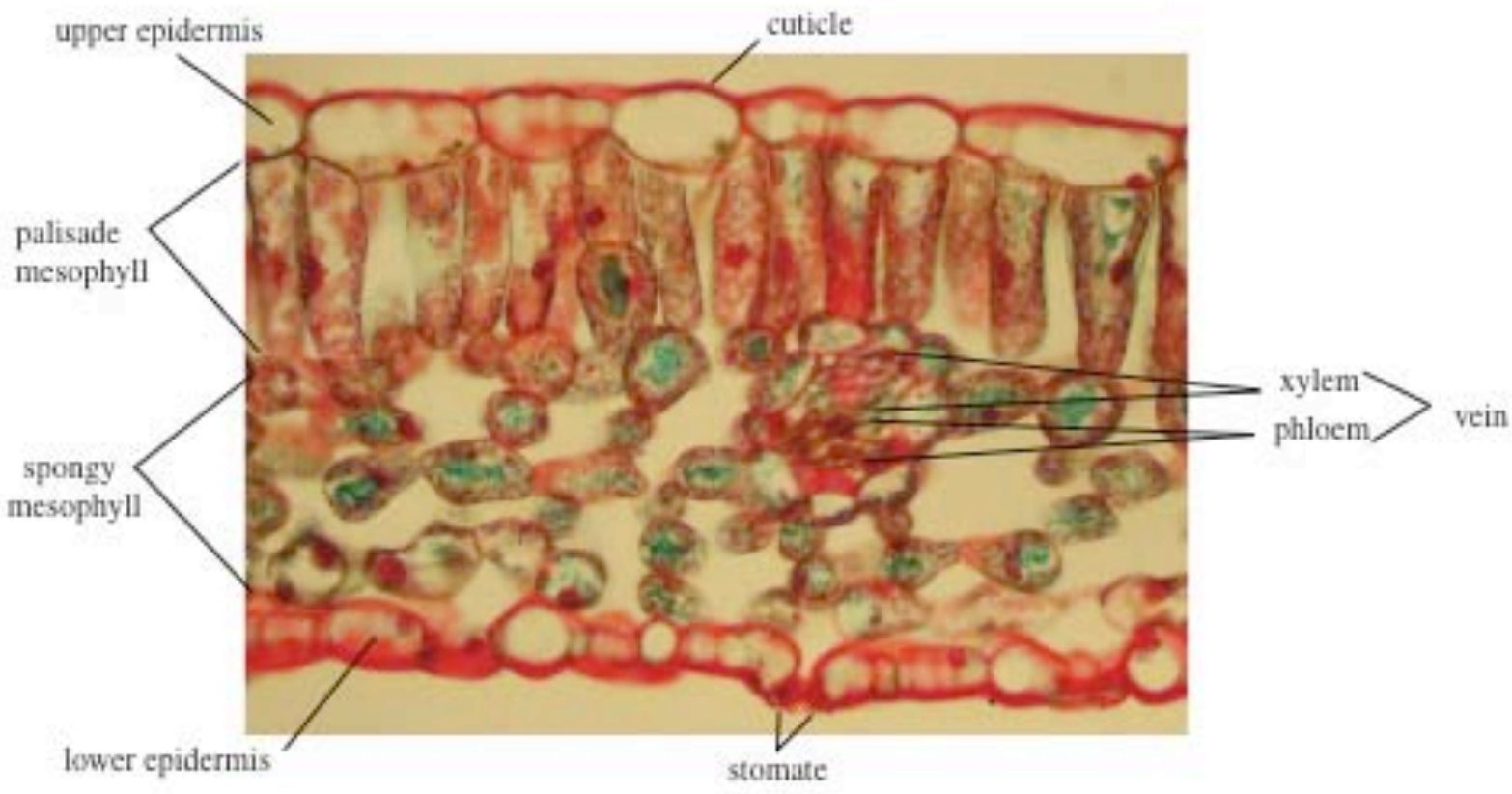


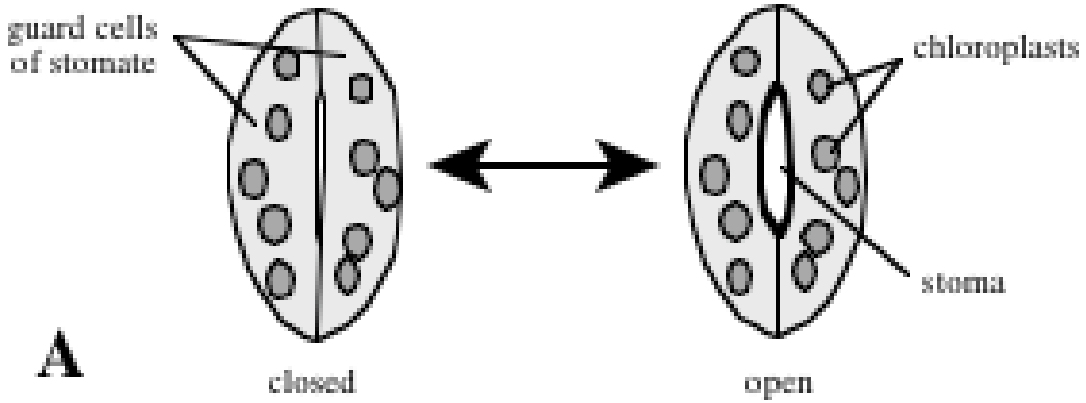
Monocots

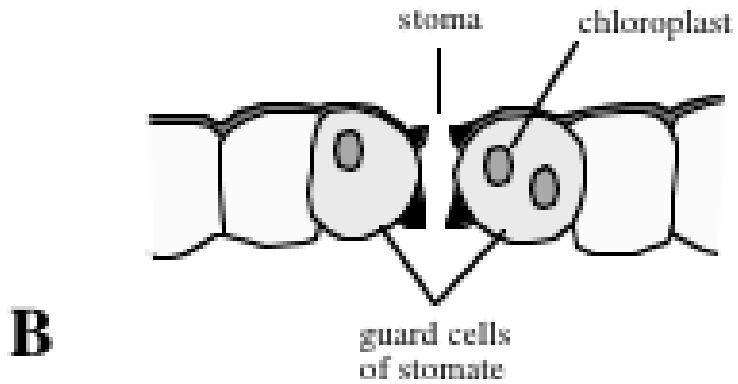
stem with many scattered bundles (atactostele)



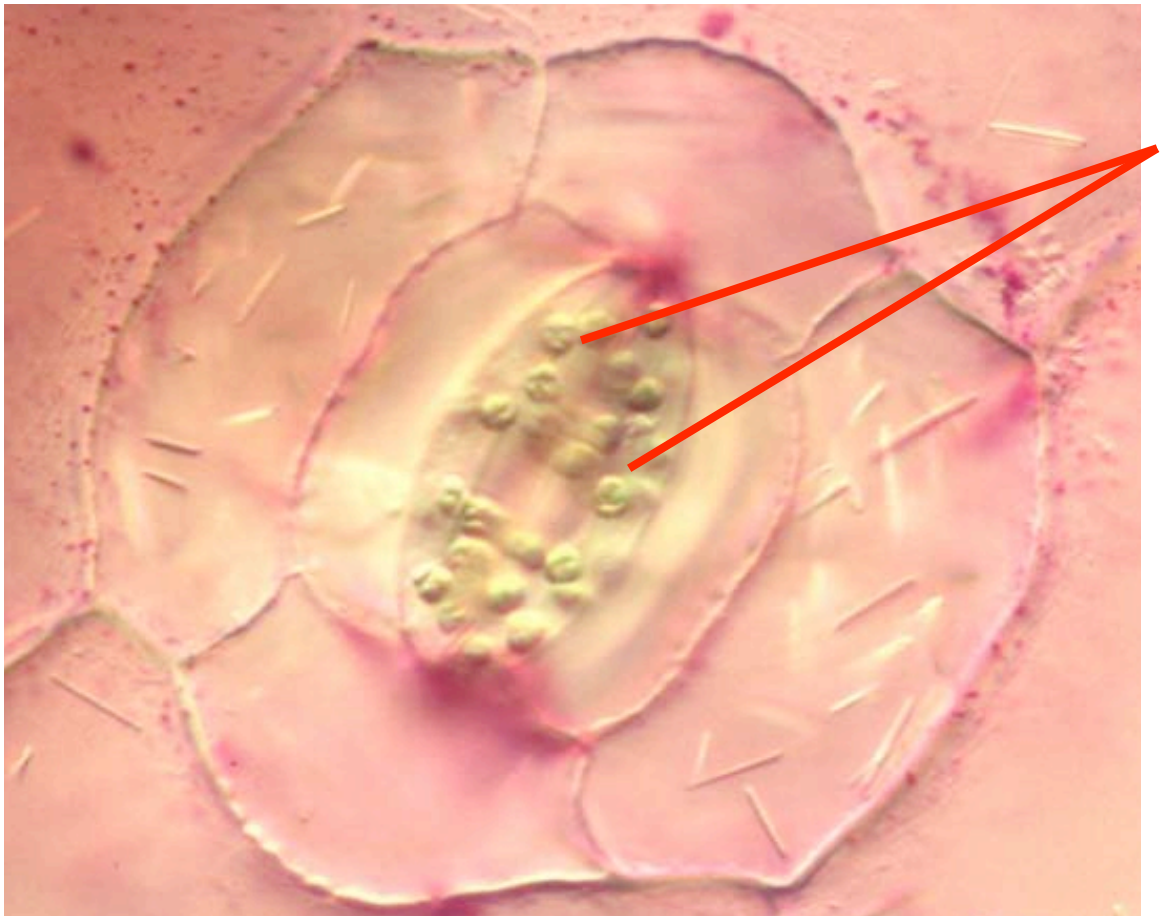
Leaf anatomy





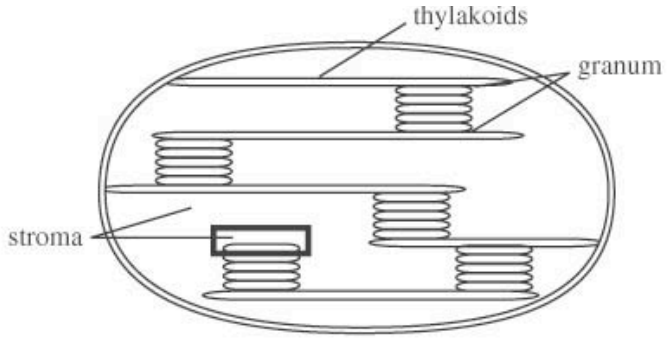


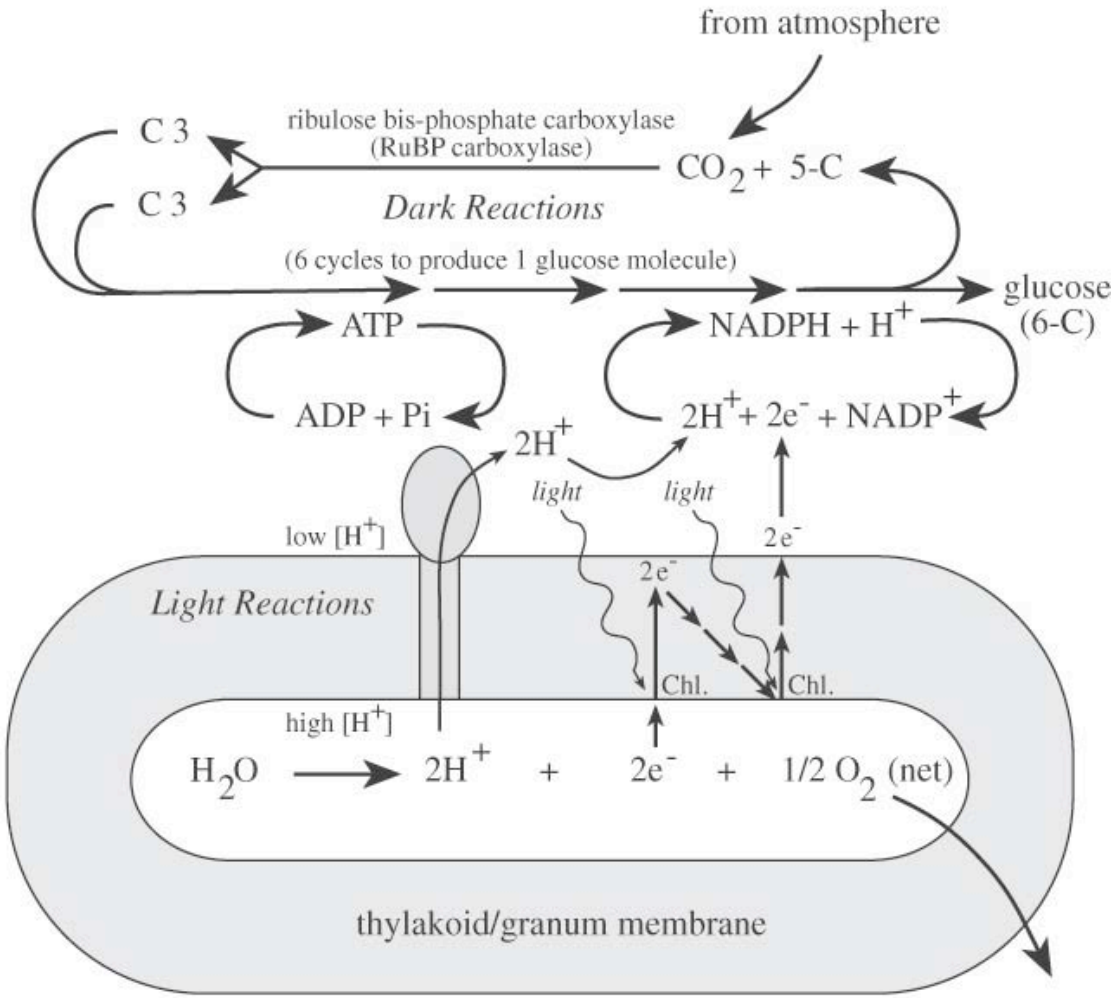
stomate: controls gas exchange of CO_2 & H_2O



2 guard cells

C3 photosynthesis: Normal type

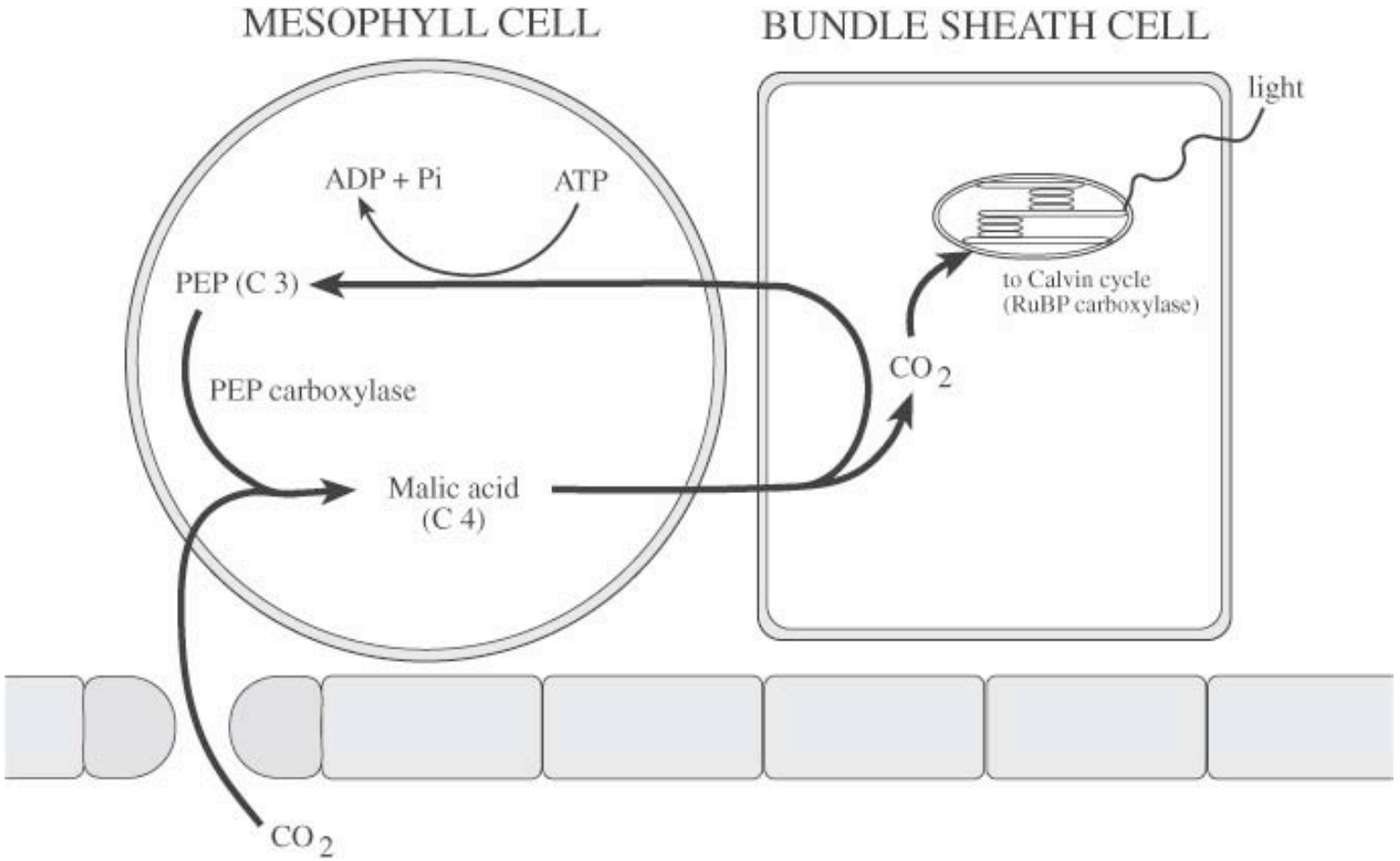




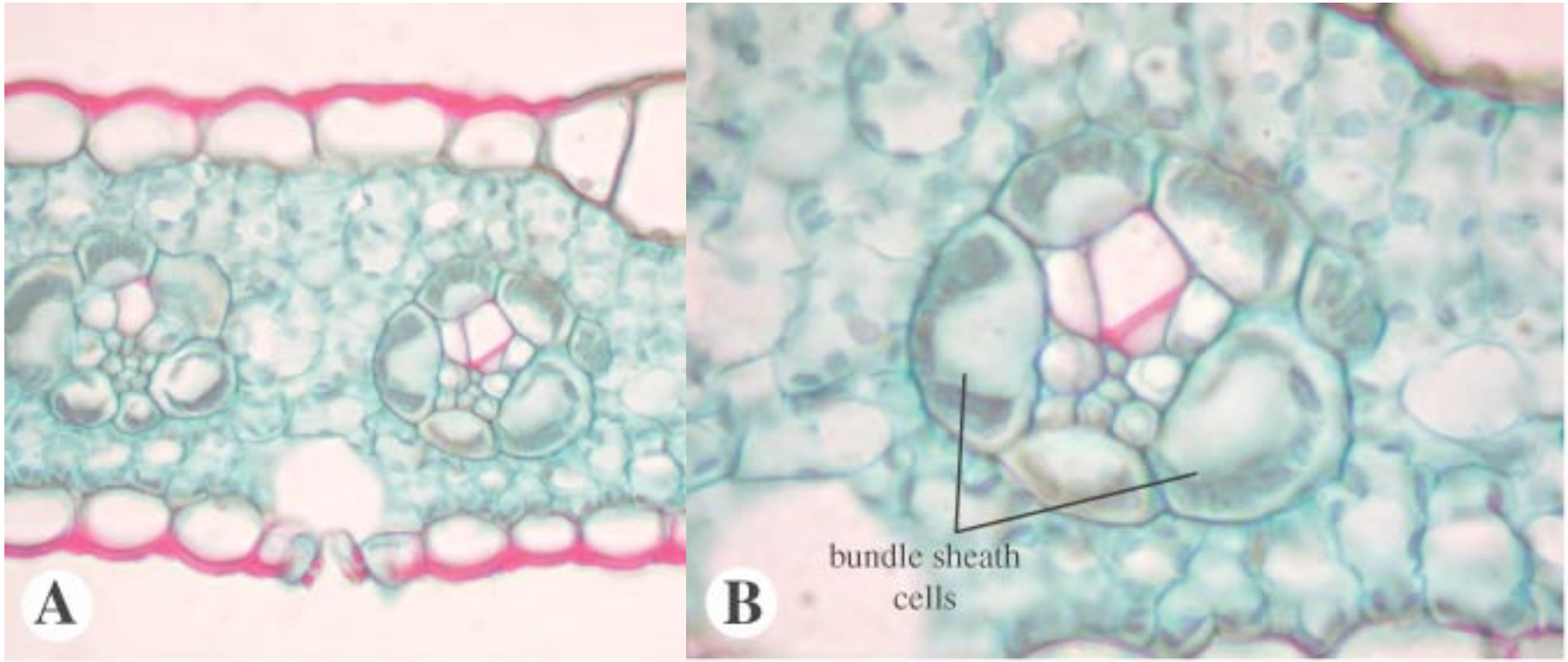
C4 photosynthesis:

PEP (C3) + CO_2 --> Malic acid (C4) [Mesophyll]

Malic acid --> CO2 + PEP (C3) [B.S.C.]



Kranz anatomy (in C4 plants):
enlarged **Bundle Sheath Cells** w/ large chloroplasts



CAM photosynthesis: CO2 fixed at night (stomates open), released in day (stomates closed)